

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re PATENT APPLICATION of  
Inventor(s): Mills

Group Art Unit: 1745

Appln. Ser. No.: 09/501,622

Secret Committee: Kalafut *for the*  
*Secret Committee*

Filing Date: 02/09/2000

Title: DOPED SEMICONDUCTOR AND METHOD OF MAKING THE DOPED  
SEMICONDUCTOR

July 26, 2005

**RESPONSE TO FINAL OFFICE ACTION AND NOTICE OF APPEAL**

Commissioner of Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

07/27/2005 SDENBOB1 00000039 09501622

01 FC:2401  
02 FC:2253

250.00 OP  
510.00 OP

Sir:

Applicant files this Response to the Final Office Action mailed January 26, 2005. Please consider this paper as a Notice of Appeal and as a petition for three months extension.

Reconsideration and allowance of the above-identified application is respectfully requested. Claims 1-265 are pending in the present application.

Submitted with this Response is new, non-cumulative scientific evidence further demonstrating the existence of lower energy states of hydrogen in a number of different ways, including, but not limited to, studies of spectroscopic lines, energy output, compositions of matter, generated plasmas, and inverted hydrogen populations. As detailed below, Applicant also identifies independent third-party data pursuant to the PTO's agreement, which evidence resulted in verbal confirmation by Examiner Wayne Langel that two BlackLight applications formally handled by him were allowable before he was told to misrepresent that fact and, thus, was forced to resign from examining those cases "for moral and ethical reasons."

As further revealed by Examiner Langel, and confirmed by two other Examiners, "allowance is not an option" in any pending BlackLight application according to official PTO policy. Under that arbitrary policy, the anonymous group of individuals, i.e. "Secret Committee," responsible for directing the named Examiner's actions in this case has knowingly violated well-established patent laws and procedures in presuming the utility of Applicant's novel hydrogen technology to be *per se* incredible as an excuse for its failure to properly consider and evaluate the scientific evidence of record amassed by Applicant at great expense. [See, e.g., MPEP § 2107, pp. 2100-31 ("A conclusion that an asserted utility is incredible can be reached only after the Office has evaluated both the assertion of the applicant regarding utility and any evidentiary basis of that assertion. The [Examiner] should be particularly careful not to start with a presumption that an asserted utility is, *per se*, "incredible" and then proceed to base a rejection under 35 U.S.C. 101 on that presumption." )]]

To the limited extent that the Committee has begun to address Applicant's evidence in any of his pending cases, it has done so by relying primarily upon the biased views of its newest principal member, Dr. Bernard Eng-Kie Souw, who was assigned to replace Examiner Langel and examine all of BlackLight's pending applications. As discussed below, those biased views lack credibility not just on the merits, but also due to a genuine conflict of interest involving Dr. Souw's contemporaneous ownership of, and work as the lead scientist for, a company that competes with BlackLight in the same technical areas. Consequently, the Committee's rejections in all of BlackLight's cases, including this one, which have adopted Dr. Souw's biased views, are fatally defective and should be immediately withdrawn so that these cases can be allowed to issue.

The rejection of the claims 1-265 under 35 U.S.C. § 101 as being inoperative and lacking utility is respectfully traversed. Applicant respectfully submits that the Committee has not met its burden of raising a *prima facie* case of inoperability for the many reasons of record and, therefore, the rejection should be withdrawn for those reasons alone. Furthermore, Applicant has disclosed substantial experimental evidence in the present disclosure, prior submissions, and submissions herewith that fully rebut any *prima facie* case of inoperability the Committee might have raised. Applicant

responds more fully to the Committee's comments, discusses the experimental evidence of record, and summarizes the improper prosecution procedures used by the Committee in the following paragraphs. For these additional reasons, the Section 101 rejection should be withdrawn.

The related rejection of claims 1-265 under 35 U.S.C. § 112, first paragraph, as lacking enablement, is also respectfully traversed. Applicant respectfully submits that the Committee has not met its burden of raising a *prima facie* case of lack of enablement for the many reasons of record and, therefore, the rejection should be withdrawn for those reasons alone. Furthermore, Applicant has disclosed substantial experimental evidence in the present disclosure, prior submissions, and submissions herewith that fully rebut any *prima facie* case of lack of enablement the Committee might have raised. Applicant responds more fully to the Committee's comments, discusses the experimental evidence of record, and summarizes the improper prosecution procedures used by the Committee in the following paragraphs. For these additional reasons, the Section 112, first paragraph, rejection should be withdrawn.

Applicant has filed Rule 132 Declarations certifying his submitted experimental evidence, which further rebuts the Committee's unjustified utility and enablement rejections of the claimed invention. This evidence, which the Committee required Applicant to make public by submitting it to scientific journals for publication, conclusively confirms the formation of lower-energy hydrogen through practice of Applicant's novel hydrogen chemistry. To this day, the Committee has failed to properly consider the numerous Rule 132 Declarations previously filed by Applicant in violation of its own rules, as outlined in MPEP § 716:

Evidence traversing rejections must be considered by the examiner whenever present. All entered affidavits, declarations, and other evidence traversing rejections are acknowledged and commented upon by the examiner in the next succeeding action. ... Where the evidence is insufficient to overcome the rejection, the examiner must specifically explain why the evidence is insufficient. General statements such "the declaration lacks technical validity" or "the evidence is not commensurate with the scope of the claims" without an explanation supporting such findings are insufficient. [Emphasis added.]

The Committee does not even mention, let alone consider, most of the certified experimental evidence identified in Applicant's Rule 132 Declarations that were submitted to overcome the rejections of record.

#### **Lower-Energy Hydrogen Experimental Data**

With this latest submission, Applicant now has over 100 articles and books of record in this case, as reflected in the "List of References" set forth below. These articles detail studies that experimentally confirm a novel reaction of atomic hydrogen, which produces hydrogen in fractional quantum states that are at lower energies than the traditional "ground" ( $n = 1$ ) state, a chemically generated or assisted plasma (rt-plasma), and novel hydride compounds, including:

extreme ultraviolet (EUV) spectroscopy,<sup>1</sup>  
characteristic emission from catalysis and the hydride ion products,<sup>2</sup>  
lower-energy hydrogen emission,<sup>3</sup>  
plasma formation,<sup>4</sup>  
Balmer  $\alpha$  line broadening,<sup>5</sup>  
population inversion of hydrogen lines,<sup>6</sup>  
elevated electron temperature,<sup>7</sup>  
anomalous plasma afterglow duration,<sup>8</sup>  
power generation,<sup>9</sup>  
excessive light emission,<sup>10</sup> and  
analysis of chemical compounds.<sup>11</sup>

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<sup>1</sup> Reference Nos. 11-16, 20, 24, 27-29, 31-36, 39, 42-43, 46-47, 50-52, 54-55, 57, 59, 63, 65-68, 70-76, 78-79, 81, 83, 85, 86, 89, 91-93, 95-96, 98, 101, 104, 108-112.

<sup>2</sup> Reference Nos. 24, 27, 32, 39, 42, 46, 51-52, 55, 57, 68, 72-73, 81, 89, 91, 108.

<sup>3</sup> Reference Nos. 14, 28-29, 33-36, 50, 63, 67, 70-71, 73, 75-76, 78-79, 86-87, 90, 92, 93, 98, 101, 104, 110-112.

<sup>4</sup> Reference Nos. 11-13, 15-16, 20, 24, 27, 32, 39, 42, 46-47, 51-52, 54-55, 57, 72, 81, 89, 91-93, 108, 109.

<sup>5</sup> Reference Nos. 16, 20, 30, 33-37, 39, 42-43, 49, 51-52, 54-55, 57, 63-65, 68-69, 71-74, 81-85, 88-89, 91, 92, 93, 95-97, 105, 108, 109.

<sup>6</sup> Reference Nos. 39, 46, 51, 54, 55, 57, 59, 65-66, 68, 74, 83, 85, 89, 91.

<sup>7</sup> Reference Nos. 34-37, 43, 49, 63, 67, 73.

<sup>8</sup> Reference Nos. 12-13, 47, 81.

<sup>9</sup> Reference Nos. 30-31, 33, 35-36, 39, 43, 50, 63, 71-73, 76-77, 81, 84, 89, 92, 93, 98, 101, 104, 108, 110-112.

<sup>10</sup> Reference Nos. 11, 16, 20, 23, 31, 37, 43, 52, 72, 109.

<sup>11</sup> Reference Nos. 6-10, 19, 25, 38, 41, 44-45, 60-62, 64, 69, 75, 81-82, 87-88, 90, 92, 93, 94, 98, 100, 101, 104, 108, 110-112.



In addition, Applicant has shown that direct plasma to electric power conversion is possible using this novel hydrogen chemistry.<sup>12</sup>

A summary of Applicant's experimental data confirming the existence of lower-energy hydrogen is set forth below:

1.) the observation of intense extreme ultraviolet (EUV) emission at low temperatures (e.g.  $\approx 10^3$  K) from atomic hydrogen and only those atomized elements or gaseous ions which provide a net enthalpy of reaction of approximately  $m \cdot 27.2$  eV via the ionization of  $t$  electrons to a continuum energy level where  $t$  and  $m$  are each an integer (e.g. K and Cs atoms and  $Rb^+$  and  $Sr^+$  ions ionize at integer multiples of the potential energy of atomic hydrogen and caused emission; whereas, the chemically similar atoms, Na, Mg, and Ba, do not ionize at integer multiples of the potential energy of atomic hydrogen and caused no emission)<sup>13</sup>,

2.) the observation of novel EUV emission lines from microwave and glow discharges of helium with 2% hydrogen with energies of  $q \cdot 13.6$  eV where  $q = 1, 2, 3, 4, 6, 7, 8, 9, 11, 12$  or these lines inelastically scattered by helium atoms in the excitation of  $He(1s^2)$  to  $He(1s^1 2p^1)$  that were identified as hydrogen transitions to electronic energy levels below the "ground" state corresponding to fractional quantum numbers<sup>14</sup>,

3.) the observation of novel EUV emission lines from microwave and glow discharges of helium with 2% hydrogen at 44.2 nm and 40.5 nm with energies of  $q \cdot 13.6 + \left( \frac{1}{n_f^2} - \frac{1}{n_i^2} \right) \cdot 13.6$  eV where  $q = 2$  and  $n_f = 2, 4$   $n_i = \infty$  that corresponded to multipole coupling to give two-photon emission from a continuum excited state atom and an atom undergoing fractional Rydberg state transition<sup>15</sup>,

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<sup>12</sup> Reference Nos. 18, 26, 40, 48, 56, 68

<sup>13</sup> Reference Nos. 11-13, 15-16, 20, 24, 27, 32, 39, 42, 46-47, 51-52, 54-55, 57, 72, 81, 89, 91-93, 108, 109

<sup>14</sup> Reference Nos. 28, 33-36, 50, 63, 67, 71, 73, 75-76, 78, 86-87, 90

<sup>15</sup> Reference Nos. 36, 71, 73

4.) the identification of transitions of atomic hydrogen to lower energy levels corresponding to lower-energy hydrogen atoms in the extreme ultraviolet emission spectrum from interstellar medium and the sun<sup>16</sup>,

5.) the observation that the novel EUV series of lines with energies of  $q \cdot 13.6 \text{ eV}$  was observed with an Evenson microwave cell, only the peak corresponding to  $q = 2$  was observed with an RF cell, and none of the peaks were observed with a glow discharge cell<sup>17</sup>,

6.) the observation that in a comparison of Evenson, McCarroll, cylindrical, and Beenakker microwave cavity plasmas, the novel EUV series of lines with energies of  $q \cdot 13.6 \text{ eV}$  was only observed for Evenson-cavity helium-hydrogen plasmas<sup>18</sup>,

7.) the EUV spectroscopic observation of lines for a hydrogen- $K$  catalyst plasma by the Institut für Niedertemperatur-Plasmaphysik e.V. that could be assigned to transitions of atomic hydrogen to lower energy levels corresponding to fractional principal quantum numbers and the emission from the excitation of the corresponding hydride ions<sup>19</sup>,

8.) the recent analysis of mobility and spectroscopy data of individual electrons in liquid helium which shows direct experimental confirmation that electrons may have fractional principal quantum energy levels<sup>20</sup>,

9.) the observation of novel EUV emission lines from microwave discharges of argon or helium with 10% hydrogen that matched those predicted for the reaction  $H(1/4) + H^+ \rightarrow H_2(1/4)^+$  having an energy spacing of  $2^2$  times the transition-state vibrational energy of  $H_2^+$  with the series ending on the bond energy of  $H_2(1/4)^+$ <sup>21</sup>,

10.) the result that the novel vibrational series for the reaction  $H(1/4) + H^+ \rightarrow H_2(1/4)^+$  was only observed for catalyst plasmas of helium, neon, and argon mixed with hydrogen, but not with noncatalyst xenon or krypton mixed plasmas<sup>22</sup>,

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<sup>16</sup> Reference Nos. 1, 5, 17, 28-29

<sup>17</sup> Reference Nos. 71, 73

<sup>18</sup> Reference No. 76

<sup>19</sup> Reference No. 14

<sup>20</sup> Reference Nos. 17, 53

<sup>21</sup> Reference Nos. 29, 70, 73, 79, 92, 93, 98, 101, 104

<sup>22</sup> Reference Nos. 29, 70, 73, 79, 92, 93, 101

11.) the observation that based on the intensities of the peaks, the catalyst and the plasma source dependence of the reaction rate to form  $H_2(1/4)^+$  is  $Ar^+ > He^+ > Ne^+$  and microwave > glow discharge >> RF, respectively<sup>23</sup>,

12.) the observation that the microwave plasma source dependence of the reaction rate to form  $H_2(1/4)^+$  is Evenson microwave > McCarroll, cylindrical, Beenakker<sup>24</sup>,

13.) the observation of a series of vibration-rotational bands in the 60-67 nm region, a high-energy region for which vibration-rotational spectra are ordinarily unknown, emitted from low-pressure helium-hydrogen (99/1%) microwave plasmas that matched the predicted energy spacing of the vibrational energy of  $H_2$  about the bond energy of  $H_2(1/2)$  corresponding to the reaction  $2H(1/2) \rightarrow H_2(1/2)$ <sup>25</sup>,

14.) the observation of EUV plasma emission spectra in the region 60 nm to 100 nm that matched the predicted emission lines  $E_{D_{H_2}}$  due to the reaction  $2H(1/2) \rightarrow H_2(1/2)$  with vibronic coupling at energies of  $E_{D+vib} = 17.913 \pm \left(\frac{\nu^*}{3}\right) 0.515902 \text{ eV}$  to longer wavelengths for  $\nu^* = 2$  to  $\nu^* = 32$  and to shorter wavelengths for  $\nu^* = 1$  to  $\nu^* = 16$  to within the spectrometer resolution of about  $\pm 0.05\%$ <sup>26</sup>,

15.) the observation that in addition to members of the series of novel emission lines with energies of  $q \cdot 13.6 \text{ eV}$  or  $E_{D+vib} = 17.913 \pm \left(\frac{\nu^*}{3}\right) 0.515902 \text{ eV}$  an additional intense peak was observed from a scaled-up Evenson cell at 41.6 nm with an energy of 29.81 eV that matched  $q \cdot 13.6 \text{ eV}$  with  $q = 4$  less 24.58741 eV corresponding to inelastic scattering of these photons by helium atoms due to ionization of He to  $He^+$ <sup>27</sup>,

16.) the observation that in a comparison of Evenson, McCarroll, cylindrical, and Beenakker microwave cavity plasmas, the novel series of spectral lines due to the reaction

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<sup>23</sup> Reference No. 70

<sup>24</sup> Reference No. 79

<sup>25</sup> Reference No. 99

<sup>26</sup> Reference Nos. 50, 75-76, 78, 86-87, 90

<sup>27</sup> Reference No. 86

$2H(1/2) \rightarrow H_2(1/2)$  with vibronic coupling at energies of  $E_{D+vib} = 17.913 \pm \left(\frac{\nu^*}{3}\right) 0.515902 \text{ eV}$  was only observed for Evenson-cavity helium-hydrogen and neon-hydrogen plasmas<sup>28</sup>,

17.) the observation by gas chromatography that hydrogen was consumed by the helium-hydrogen plasmas which showed the novel EUV series of lines with energies of  $q \cdot 13.6 \text{ eV}$ , the novel series of spectral lines due to the reaction  $2H(1/2) \rightarrow H_2(1/2)$  with vibronic coupling at energies of  $E_{D+vib} = 17.913 \pm \left(\frac{\nu^*}{3}\right) 0.515902 \text{ eV}$ , extraordinary H Balmer line broadening corresponding to 180 - 210  $\text{eV}$ , and excess power of 21.9 W in 3  $\text{cm}^3$ <sup>29</sup>,

18.) the observation of the dominant  $He^+$  emission and an intensification of the plasma emission observed when  $He^+$  was present with atomic hydrogen demonstrated the role of  $He^+$  as a catalyst<sup>30</sup>,

19.) the observation of continuum state emission of  $Cs^{2+}$  and  $Ar^{2+}$  at 53.3  $\text{nm}$  and 45.6  $\text{nm}$ , respectively, with the absence of the other corresponding Rydberg series of lines from these species which confirmed the resonant nonradiative energy transfer of 27.2  $\text{eV}$  from atomic hydrogen to the either  $Cs$  or  $Ar^+$  catalyst<sup>31</sup>,

20.) the spectroscopic observation of the predicted hydride ion  $H^-(1/2)$  of hydrogen catalysis by either  $Cs$  or  $Ar^+$  catalyst at 407  $\text{nm}$  corresponding to its predicted binding energy of 3.05  $\text{eV}$ <sup>32</sup>,

21.) the observation of characteristic emission from  $K^{3+}$  which confirmed the resonant nonradiative energy transfer of  $3 \cdot 27.2 \text{ eV}$  from atomic hydrogen to atomic  $K^{33}$ ,

22.) the spectroscopic observation of the predicted  $H^-(1/4)$  ion of hydrogen catalysis by  $K$  catalyst at 110  $\text{nm}$  corresponding to its predicted binding energy of 11.2  $\text{eV}$ <sup>34</sup>,

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<sup>28</sup> Reference No. 76

<sup>29</sup> Reference No. 76

<sup>30</sup> Reference Nos. 36, 73

<sup>31</sup> Reference Nos. 24, 39, 51, 54-55, 57, 91

<sup>32</sup> Reference No. 24

<sup>33</sup> Reference Nos. 27, 39, 42, 46, 51, 54-55, 57, 81, 89, 91

<sup>34</sup> Reference Nos. 81, 42, 27

23.) the observation of characteristic emission from  $Rb^{2+}$  which confirmed the resonant nonradiative energy transfer of  $27.2\text{ eV}$  from atomic hydrogen to  $Rb^{+35}$ ,

24.) the spectroscopic observation of the predicted  $H^-(1/2)$  ion of hydrogen catalysis by  $Rb^+$  catalyst at  $407\text{ nm}$  corresponding to its predicted binding energy of  $3.05\text{ eV}^{36}$ ,

25.) the observation of  $H^-(1/2)$ , the hydride ion catalyst product of  $K^+ / K^+$  or  $Rb^+$ , at its predicted binding energy of  $3.0468\text{ eV}$  by high resolution visible spectroscopy as a continuum threshold at  $4068.2\text{ \AA}$  and a series of structured peaks separated from the binding energy by an integer multiple of the fine structure of  $H(1/2)$  starting at  $4071\text{ \AA}$  that matched predicted free-free transitions<sup>37</sup>,

26.) the observation that the high resolution visible  $K^+ / K^+$  or  $Rb^+ - H_2$  plasma emission spectra in the region of  $3995$  to  $4060\text{ \AA}$  matched the predicted bound-free hyperfine structure lines  $E_{HF}$  of  $H^-(1/2)$  calculated from the electron  $g$  factor as  $E_{HF} = j^2 3.00213 \times 10^{-5} + 3.0563\text{ eV}$  ( $j$  is an integer) for  $j = 1$  to  $j = 39$  ( $3.0563\text{ eV}$  to  $3.1012\text{ eV}$ —the hydride binding energy peak plus one and five times the spin-pairing energy, respectively) to within a 1 part per  $10^{438}$ ,

27.)  $Rb^+$  or  $2K^+$  catalysts formed a plasma having strong VUV emission with a stationary inverted Lyman population with an overpopulation sufficient for lasing, and emission from  $H^-(1/2)$  was observed at  $4071\text{ \AA}$  corresponding to its predicted binding energy of  $3.0468\text{ eV}$  with the fine structure and its predicted bound-free hyperfine structure lines  $E_{HF} = j^2 3.00213 \times 10^{-5} + 3.0563\text{ eV}$  ( $j$  is an integer) that matched for  $j = 1$  to  $j = 37$  to within a 1 part per  $10^{439}$ ,

28.) the observation of stationary inverted H Balmer and Lyman populations from a low pressure water-vapor microwave discharge plasma with an overpopulation sufficient for lasing at wavelengths over a wide range from micron to blue wherein molecular oxygen

<sup>35</sup> Reference Nos. 32, 39, 42, 46, 51, 54-55, 57, 81, 89, 91

<sup>36</sup> Reference No. 32

<sup>37</sup> Reference Nos. 39, 42, 46, 57, 81, 89, 91

<sup>38</sup> Reference Nos. 39, 42, 46, 57, 81, 89, 91

<sup>39</sup> Reference Nos. 39, 42, 46, 51, 54, 55, 57, 81, 89, 91

served as the catalyst as supported by  $O^{2+}$  emission and H Balmer line broadening of 55 eV compared to 1 eV for hydrogen alone<sup>40</sup>,

29.) the observation of H Balmer line broadening of 55 eV compared to 1 eV for hydrogen alone at distances up to 5 cm from the coupler<sup>41</sup>,

30.) the observation that with a microwave input power of  $9 \text{ W} \cdot \text{cm}^{-3}$ , a collisional radiative model showed that the hydrogen excited state population distribution was consistent with an  $n = 1 \rightarrow 5, 6$  pumping power of an unprecedented  $200 \text{ W} \cdot \text{cm}^{-3}$  permissive of gas laser efficiencies orders of magnitude those of conventional visible gas lasers and direct generation of electrical power using photovoltaic conversion of the spontaneous or stimulated water vapor plasma emission<sup>42</sup>;

31.) the observation of stimulation of the stationary inverted H Balmer population from a low pressure water-vapor microwave discharge plasma by back illumination with an infrared source that showed depopulation of the  $n = 5$  state<sup>43</sup>,

32.) the observation of stationary inverted H Balmer and Lyman populations from a low pressure water-vapor microwave discharge plasma with an overpopulation sufficient for lasing was observed for Evenson microwave plasmas, but not for RF or discharge plasmas<sup>44</sup>,

33.) the observation of stationary inverted H Balmer and Lyman populations from a low pressure water-vapor microwave discharge plasma with an overpopulation sufficient for lasing that was dependent on the microwave plasma source with the highest inversion from Evenson microwave plasmas<sup>45</sup>,

34.) the observation of stationary inverted H Balmer and Lyman populations from a low pressure water-vapor microwave discharge plasma with an overpopulation sufficient for lasing that was dependent on the pressure of the Evenson microwave plasma<sup>46</sup>,

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<sup>40</sup> Reference Nos. 59, 65-66, 68, 74, 83, 85

<sup>41</sup> Reference No. 74

<sup>42</sup> Reference Nos. 68, 83, 85

<sup>43</sup> Reference Nos. 59, 65, 68, 85

<sup>44</sup> Reference Nos. 59, 65-66, 68, 73, 83, 85

<sup>45</sup> Reference No. 83

<sup>46</sup> Reference Nos. 59, 68, 73, 83, 85

35.) the observation of stationary inverted H Balmer populations from a low pressure water-vapor microwave discharge plasma with an overpopulation sufficient for lasing at distances up to 5 cm from the coupler<sup>47</sup>,

36.) the observation that the requirement for the natural hydrogen-oxygen stoichiometry of the Evenson water plasma was stringent in that a deviation by over 2% excess of either gas caused a reversal of the H inversion in water vapor plasmas<sup>48</sup>,

37.) the observation of a typical slow H population for a water-vapor plasma maintained in a GEC-type cell that was independent of time, and a new phenomenon, an extraordinary fast population that increased from zero to a significant portion of the Balmer  $\alpha$  emission with time under no-flow conditions wherein the peak width and energy increased with time up to a 0.7 nm half-width corresponding to an average hydrogen atom energy of 200 eV<sup>49</sup>,

38.) the observation of a substantial fast H population (~20% at 40 eV) for a water-vapor plasmas maintained in a GEC-type cell that was independent of position including regions where the electric field was orders of magnitude too low to explain the extraordinarily high Doppler energies<sup>50</sup>,

39.) the observation of fast H population (40-50 eV) for  $He/H_2$  (95/5%),  $Ar/H_2$  (95/5%), and  $H_2$  plasmas maintained in a GEC-type cell that was independent of position including regions where the electric field was orders of magnitude too low to explain the extraordinarily high Doppler energies<sup>51</sup>,

40.) the observation by the Institut für Niedertemperatur-Plasmaphysik e.V. of an anomalous plasma and plasma afterglow duration formed with hydrogen-potassium mixtures<sup>52</sup>,

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<sup>47</sup> Reference No. 74

<sup>48</sup> Reference Nos. 59, 68, 83, 85

<sup>49</sup> Reference No. 95

<sup>50</sup> Reference No. 96

<sup>51</sup> Reference Nos. 92, 93, 97, 105

<sup>52</sup> Reference Nos. 13, 47, 81

41.) the observation of anomalous afterglow durations of plasmas formed by catalysts providing a net enthalpy of reaction within thermal energies of  $m \cdot 27.28 \text{ eV}$ <sup>53</sup>,

42.) the formation of a chemically generated hydrogen plasma with the observation of Lyman series in the EUV that represents an energy release about 10 times that of hydrogen combustion which is greater than that of any possible known chemical reaction<sup>54</sup>,

43.) the observation of line emission by the Institut für Niedertemperatur-Plasmaphysik e.V. with a 4° grazing incidence EUV spectrometer that was 100 times more energetic than the combustion of hydrogen<sup>55</sup>,

44.) the excessive increase in the Lyman emission upon the addition of helium or argon catalyst to a hydrogen plasma<sup>56</sup>,

45.) the observation of the characteristic emission from  $Sr^+$  and  $Sr^{3+}$  that confirmed the resonant nonradiative energy transfer of  $2 \cdot 27.2 \text{ eV}$  from atomic hydrogen to  $Sr^+$ <sup>57</sup>,

46.) the observation of anomalous plasmas formed with  $Sr$  and  $Ar^+$  catalysts at 1% of the theoretical or prior known voltage requirement with a light output per unit power input up to 8600 times that of the control standard light source<sup>58</sup>,

47.) the observation that the optically measured output power of gas cells for power supplied to the glow discharge increased by over two orders of magnitude depending on the presence of less than 1% partial pressure of certain catalysts in hydrogen gas or argon-hydrogen gas mixtures, and an excess thermal balance of 42 W was measured for the 97% argon and 3% hydrogen mixture versus argon plasma alone<sup>59</sup>,

48.) the observation that glow discharge plasmas of the catalyst-hydrogen mixtures of strontium-hydrogen, helium-hydrogen, argon-hydrogen, strontium-helium-hydrogen, and strontium-argon-hydrogen showed significant Balmer  $\alpha$  line broadening corresponding to an

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<sup>53</sup> Reference Nos. 12, 13, 47, 81,

<sup>54</sup> Reference Nos. 11-13, 15-16, 20, 24, 27, 32, 39, 42, 46-47, 51-52, 54-55, 57, 72, 81, 89, 91, 109

<sup>55</sup> Reference No. 14

<sup>56</sup> Reference Nos. 20, 31, 37, 43

<sup>57</sup> Reference Nos. 16, 52

<sup>58</sup> Reference Nos. 11, 16, 20, 23, 52, 72

<sup>59</sup> Reference No. 22



average hydrogen atom temperature of 25 - 45  $eV$ ; whereas, plasmas of the noncatalyst-hydrogen mixtures of pure hydrogen, krypton-hydrogen, xenon-hydrogen, and magnesium-hydrogen showed no excessive broadening corresponding to an average hydrogen atom temperature of  $\approx 3 eV$ <sup>60</sup>,

49.) the observation that microwave helium-hydrogen and argon-hydrogen plasmas having catalyst  $Ar^+$  or  $He^+$  showed extraordinary Balmer  $\alpha$  line broadening due to hydrogen catalysis corresponding to an average hydrogen atom temperature of 110 - 130  $eV$  and 180 - 210  $eV$ , respectively; whereas, plasmas of pure hydrogen, neon-hydrogen, krypton-hydrogen, and xenon-hydrogen showed no excessive broadening corresponding to an average hydrogen atom temperature of  $\approx 3 eV$ <sup>61</sup>,

50.) the observation that microwave helium-hydrogen and argon-hydrogen plasmas showed average electron temperatures that were high,  $30,500 \pm 5\% K$  and  $13,700 \pm 5\% K$ , respectively; whereas, the corresponding temperatures of helium and argon alone were only  $7400 \pm 5\% K$  and  $5700 \pm 5\% K$ , respectively<sup>62</sup>,

51.) the observation of significant Balmer  $\alpha$  line broadening of 17, 9, 11, 14, and 24  $eV$  from rt-plasmas of incandescently heated hydrogen with  $K^+ / K^+$ ,  $Rb^+$ , cesium, strontium, and strontium with  $Ar^+$  catalysts, respectively, wherein the results could not be explained by Stark or thermal broadening or electric field acceleration of charged species since the measured field of the incandescent heater was extremely weak, 1 V/cm, corresponding to a broadening of much less than 1  $eV$ <sup>63</sup>,

52.) calorimetric measurement of excess power of 20 mW/cc on rt-plasmas formed by heating hydrogen with  $K^+ / K^+$  and  $Ar^+$  as catalysts<sup>64</sup>,

53.) the observation of an energy balance of  $\Delta H = -17,925 \text{ kcal} / \text{mole } KNO_3$ , about 300 times that expected for the most energetic known chemistry of  $KNO_3$ , and  $-3585 \text{ kcal} / \text{mole } H_2$ , over 60 times the hypothetical maximum enthalpy of  $-57.8 \text{ kcal} / \text{mole } H_2$  due to combustion of hydrogen with atmospheric oxygen, assuming the maximum possible

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<sup>60</sup> Reference Nos. 16, 20, 30, 52, 72

<sup>61</sup> Reference Nos. 33-37, 43, 49, 60, 63-64, 69, 71, 73-74, 82, 84, 88

<sup>62</sup> Reference Nos. 34-37, 43, 49, 63, 67, 73

<sup>63</sup> Reference Nos. 39, 42, 46, 51-52, 54-55, 57, 72, 81, 89, 91, 108, 109

<sup>64</sup> Reference Nos. 39, 81, 89, 108

$H_2$  inventory when  $KNO_3$  and Raney nickel were used as a source of  $K$  catalyst and atomic hydrogen, respectively, to produce the corresponding exothermic reaction<sup>65</sup>;

54.) the observation of rt-plasmas formed with strontium and argon at 1% of the theoretical or prior known voltage requirement with a light output per unit power input up to 8600 times that of the control standard light source as well as an excess power of 20 mW/cm from rt-plasmas formed by  $Ar^+$  as the catalyst in an incandescent-filament cell<sup>66</sup>,

55.) the Calvet calorimetry measurement of an energy balance of over  $-151,000 \text{ kJ/mole } H_2$  with the addition of 3% hydrogen to a plasma of argon having the catalyst  $Ar^+$  compared to the enthalpy of combustion of hydrogen of  $-241.8 \text{ kJ/mole } H_2$ ; whereas, under identical conditions no change in the Calvet voltage was observed when hydrogen was added to a plasma of noncatalyst xenon<sup>67</sup>,

56.) the observation that the power output exceeded the power supplied to hydrogen glow discharge plasmas by 35-184 W depending on the presence of catalysts from helium or argon and less than 1% partial pressure of strontium metal in noble gas-hydrogen mixtures; whereas, the chemically similar noncatalyst krypton had no effect on the power balance<sup>68</sup>,

57.) the observation that with the addition of 3% flowing hydrogen to an argon microwave plasma with a constant input power of 40 W, the gas temperature increased from 400°C to over 750°C; whereas, the 400°C temperature of a xenon plasma run under identical conditions was essentially unchanged with the addition of hydrogen<sup>69</sup>,

58.) observations of power such as that where the addition of 10% hydrogen to a helium microwave plasma maintained with a constant microwave input power of 40 W, the thermal output power was measured to be at least 280 W corresponding to a reactor temperature rise from room temperature to 1200°C within 150 seconds, a power density of  $28 \text{ MW/m}^3$ , and an energy balance of at least  $-4 \times 10^5 \text{ kJ/mole } H_2$  compared to the enthalpy of combustion of hydrogen of  $-241.8 \text{ kJ/mole } H_2$ <sup>70</sup>,

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<sup>65</sup> Reference No. 111

<sup>66</sup> Reference No. 72, 109

<sup>67</sup> Reference No. 31

<sup>68</sup> Reference No. 30

<sup>69</sup> Reference No. 43

<sup>70</sup> Reference Nos. 34, 35

59.) the observation of  $306 \pm 5 \text{ W}$  of excess power generated in  $45 \text{ cm}^3$  by a compound-hollow-cathode-glow discharge of a neon-hydrogen (99.5/0.5%) mixture corresponding to a power density of  $6.8 \text{ MW/m}^3$  and an energy balance of at least  $-1 \times 10^6 \text{ kJ/mole H}_2$  compared to the enthalpy of combustion of hydrogen of  $-241.8 \text{ kJ/mole H}_2$ <sup>71</sup>,

60.) the observation that for an input of 37.7 W, the total plasma power of the neon-hydrogen plasma measured by water bath calorimetry was 60.7 W corresponding to 23.0 W of excess power in  $3 \text{ cm}^3$ <sup>72</sup>,

61.) the observation of intense  $\text{He}^+$  emission and a total plasma power of a helium-hydrogen plasma measured by water bath calorimetry of 30.0 W for an input of 8.1 W, corresponding to 21.9 W of excess power in  $3 \text{ cm}^3$  wherein the excess power density and energy balance were high,  $7.3 \text{ W/cm}^3$  and  $-2.9 \times 10^4 \text{ kJ/mole H}_2$ , respectively<sup>73</sup>,

62.) in the comparison of helium-hydrogen plasmas sources, the observation that i.) with an input power of  $24.8 \pm 1 \text{ W}$ , the total plasma power of the Evenson microwave helium-hydrogen plasma measured by water bath calorimetry was  $49.1 \pm 1 \text{ W}$  corresponding to  $24.3 \pm 1 \text{ W}$  of excess power in  $3 \text{ cm}^3$  corresponding to a high excess power density and energy balance of  $8.1 \text{ W/cm}^3$  and over  $-3 \times 10^4 \text{ kJ/mole H}_2$ , respectively, ii.) with an input of 500 W, a total power of 623 W was generated in a  $45 \text{ cm}^3$  compound-hollow-cathode-glow discharge, iii.) less than 10% excess power was observed from inductively coupled RF helium-hydrogen plasmas, and iv.) no measurable heat was observed from MKS/Astex microwave helium-hydrogen plasmas that corresponded to the absence of H Balmer line broadening<sup>74</sup>,

63.) the observation of energy balances of helium-hydrogen microwave plasmas of over 100 times the combustion of hydrogen and power densities greater than  $10 \text{ W/cm}^3$  measured by water bath calorimetry<sup>75</sup>,

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<sup>71</sup> Reference Nos. 50, 78

<sup>72</sup> Reference No. 76

<sup>73</sup> Reference Nos. 36, 63, 71, 73

<sup>74</sup> Reference Nos. 84, 98, 104

<sup>75</sup> Reference Nos. 34-36, 50, 63, 71, 73, 76-78, 84, 92, 93, 101, 112

64.) at the load matching condition of  $600\ \Omega$ , the direct plasmadynamic conversion (PDC) of open circuit voltages of 11.5 V and ~200 mW of electrical power with a 0.125 in diameter by 3/4 in long plasmadynamic electrode and a 140 G applied field corresponding to an extracted power density of  $\sim 1.61\ \text{W}/\text{cm}^3$  and an efficiency of  $\sim 18.8\%$ <sup>76</sup>,

65.) at the load matching condition of  $250\ \Omega$ , the direct plasmadynamic conversion (PDC) of open circuit voltages of 21.8 V and 1.87 W of electrical power with a 0.125 in diameter by 3/4 in long plasmadynamic electrode and a 140 G applied field corresponding to an extracted power density of  $3.6\ \text{W}/\text{cm}^3$  and an efficiency of  $42\%$ <sup>77</sup>,

66.) the projection that the generation of electricity using magnetohydrodynamic (MHD) conversion of the plasma particle energy of small to mid-size chemically assisted microwave or glow discharge plasma (ca-plasma) power sources in the range of a few hundred Watts to several 10's of kW for microdistributed commercial applications appears feasible at 50% efficiency or better with a simple compact design<sup>78</sup>,

67.) the differential scanning calorimetry (DSC) measurement of minimum heats of formation of *KHI* by the catalytic reaction of *K* with atomic hydrogen and *KI* that were over  $-2000\ \text{kJ}/\text{mole}\ H_2$  compared to the enthalpy of combustion of hydrogen of  $-241.8\ \text{kJ}/\text{mole}\ H_2$ <sup>79</sup>,

68.) the isolation of novel hydrogen compounds as products of the reaction of atomic hydrogen with atoms and ions which formed an anomalous plasma as reported in the EUV studies<sup>80</sup>,

69.) the synthesis and identification of a novel diamond-like carbon film terminated with  $CH(1/p)$  ( $H^+DLC$ ) comprising high binding energy hydride ions was synthesized for the first time from solid carbon by a microwave plasma reaction of a mixture of 10-30% hydrogen and 90-70% helium wherein  $He^+$  served as a catalyst with atomic hydrogen to form the highly stable hydride ions and an energetic plasma<sup>81</sup>,

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<sup>76</sup> Reference No. 48

<sup>77</sup> Reference No. 56

<sup>78</sup> Reference No. 40

<sup>79</sup> Reference No. 25

<sup>80</sup> Reference Nos. 6-10, 19, 25, 38, 41, 44-45, 60-62, 75, 81, 87, 90, 92, 93, 100, 101, 108, 110-112

<sup>81</sup> Reference No. 60

70.) the synthesis of polycrystalline diamond films on silicon substrates without diamond seeding by a very low power microwave plasma reaction of a mixture of helium-hydrogen-methane (48.2/48.2/3.6%) wherein  $He^+$  served as a catalyst with atomic hydrogen to form an energetic plasma with an average hydrogen atom temperature of 180 - 210 eV versus  $\approx 3$  eV for pure hydrogen and bombardment of the carbon surface by highly energetic hydrogen formed by the catalysis reaction may play a role in the formation of diamond<sup>82</sup>,

71.) the synthesis of polycrystalline diamond films on silicon substrates without diamond seeding by a very low power microwave plasma reaction of a mixture of argon-hydrogen-methane (17.5/80/2.5%) wherein  $Ar^+$  served as a catalyst with atomic hydrogen to form an energetic plasma with an average hydrogen atom temperature of 110 - 130 eV versus  $\approx 3$  eV for pure hydrogen and bombardment of the carbon surface by highly energetic hydrogen formed by the catalysis reaction may play a role in the formation of diamond<sup>83</sup>,

72.) the identification of a novel highly stable surface coating  $SiH(1/p)$  by time of flight secondary ion mass spectroscopy that showed  $SiH^+$  in the positive spectrum and  $H^-$  dominant in the negative spectrum and by X-ray photoelectron spectroscopy which showed that the  $H$  content of the  $SiH$  coatings was hydride ions,  $H^-(1/4)$ ,  $H^-(1/9)$ , and  $H^-(1/11)$  corresponding to peaks at 11, 43, and 55 eV, respectively, and showed that the surface was remarkably stable to air<sup>84</sup>,

73.) the isolation of novel inorganic hydride compounds such as  $KHKHCO_3$  and  $KH$  following each of the electrolysis and plasma electrolysis of a  $K_2CO_3$  electrolyte which comprised high binding energy hydride ions that were stable in water with their identification by methods such as (i) ToF-SIMS on  $KHKHCO_3$  which showed inorganic hydride clusters  $K[KHKHCO_3]^+$  and a negative ToF-SIMS dominated by hydride ion, (ii) X-ray photoelectron spectroscopy which showed novel peaks corresponding to high binding energy hydride ions, and (iii)  $^1H$  nuclear magnetic resonance spectroscopy which showed upfield shifted peaks corresponding to more diamagnetic, high-binding-energy hydride ions<sup>85</sup>,

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<sup>82</sup> Reference Nos. 64, 69, 88

<sup>83</sup> Reference Nos. 82, 88

<sup>84</sup> Reference Nos. 45, 61, 100

<sup>85</sup> Reference Nos. 6-7, 9, 38, 41

74.) the identification of  $LiHCl$  comprising a high binding energy hydride ion by time of flight secondary ion mass spectroscopy which showed a dominant  $H^-$  in the negative ion spectrum, X-ray photoelectron spectroscopy which showed  $H^-$  (1/4) as a new peak at its predicted binding energy of 11 eV,  $^1H$  nuclear magnetic resonance spectroscopy which showed an extraordinary upfield shifted peak of -15.4 ppm corresponding to the novel hydride ion, and powder X-ray diffraction which showed novel peaks<sup>86</sup>,

75.) the identification of novel hydride compounds by a number of analytical methods such as (i) time of flight secondary ion mass spectroscopy which showed a dominant hydride ion in the negative ion spectrum, (ii) X-ray photoelectron spectroscopy which showed novel hydride peaks and significant shifts of the core levels of the primary elements bound to the novel hydride ions, (iii)  $^1H$  nuclear magnetic resonance spectroscopy (NMR) which showed extraordinary upfield chemical shifts compared to the NMR of the corresponding ordinary hydrides, and (iv) thermal decomposition with analysis by gas chromatography, and mass spectroscopy which identified the compounds as hydrides<sup>87</sup>,

76.) the NMR identification of novel hydride compounds  $MH^*X$  wherein  $M$  is the alkali or alkaline earth metal,  $X$ , is a halide, and  $H^*$  comprises a novel high binding energy hydride ion identified by a large distinct upfield resonance<sup>88</sup>,

77.) the replication of the NMR results of the identification of novel hydride compounds by large distinct upfield resonances at Spectral Data Services, University of Massachusetts Amherst, University of Delaware, Grace Davison, and National Research Council of Canada<sup>89</sup>,

78.) the NMR identification of novel hydride compounds  $MH^*$  and  $MH_2^*$  wherein  $M$  is the alkali or alkaline earth metal and  $H^*$  comprises a novel high binding energy hydride ion identified by a large distinct upfield resonance that proves the hydride ion is different from the hydride ion of the corresponding known compound of the same composition<sup>90</sup>,

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<sup>86</sup> Reference Nos. 44, 62

<sup>87</sup> Reference Nos. 6-10, 19, 25, 38, 41, 44-45, 60-62, 75, 81, 87, 90, 92, 93, 100, 108, 110-112

<sup>88</sup> Reference Nos. 10, 19, 41, 44, 62, 81, 108, 110-112

<sup>89</sup> Reference Nos. 19, 81, 108, 110

<sup>90</sup> Reference Nos. 19, 81, 108, 110-112

79.) the observation that the  $^1\text{H}$  MAS NMR spectrum of novel compound  $\text{KH}^*\text{Cl}$  relative to external tetramethylsilane (TMS) showed a large distinct upfield resonance at -4.4 corresponding to an absolute resonance shift of -35.9 ppm that matched the theoretical prediction of  $p = 4$ , and the novel peak of  $\text{KH}^*\text{I}$  at -1.5 ppm relative to TMS corresponding to an absolute resonance shift of -33.0 ppm matched the theoretical prediction of  $p = 2$ <sup>91</sup>,

80.) the observation that the predicted catalyst reactions, position of the upfield-shifted NMR peaks, and spectroscopic data for  $\text{H}^-(1/2)$  and  $\text{H}^-(1/4)$  were found to be in agreement<sup>92</sup>,

81.) the analysis by Infrared (FTIR) spectroscopy which eliminated any known explanation such as U centered H for the assignment of the extraordinary upfield-shifted NMR peak<sup>93</sup>,

82.) the isolation of fraction-principal-quantum-level molecular hydrogen  $\text{H}_2(1/p)$  gas by liquefaction using an ultrahigh-vacuum, liquid nitrogen cryotrap, and the observations of novel peaks by cryogenic gas chromatography, a higher ionization energy than  $\text{H}_2$  by mass spectroscopy, a substantial change in the EUV emission spectrum with deuterium substitution in a region where no hydrogen emission has ever been observed, and upfield shifted NMR peaks at 0.21, 2.18 and 3.47 ppm compared to that of  $\text{H}_2$  at 4.63 ppm<sup>94</sup>,

83.) the observation of  $^1\text{H}$  NMR singlet peaks upfield of  $\text{H}_2$  with a predicted integer spacing of 0.64 ppm at 3.47, 3.02, 2.18, 1.25, 0.85, and 0.22 ppm identified as the consecutive series  $\text{H}_2(1/2)$ ,  $\text{H}_2(1/3)$ ,  $\text{H}_2(1/4)$ ,  $\text{H}_2(1/5)$ ,  $\text{H}_2(1/6)$ , and  $\text{H}_2(1/7)$ , respectively, and  $\text{H}_2(1/10)$  at -1.8 ppm wherein  $\text{H}_2(1/p)$  gas was isolated by liquefaction at liquid nitrogen temperature, by decomposition of compounds found to contain the corresponding hydride ions  $\text{H}^-(1/p)$ , and by permeation through a hollow nickel cathode<sup>95</sup>,

84.) the observation of excess enthalpy from a  $\text{K}_2\text{CO}_3$  electrolytic cell of a factor of two times that of the resistive power dissipation and  $^1\text{H}$  NMR singlet peaks upfield of  $\text{H}_2$  with a predicted integer spacing of 0.64 ppm at 3.49, 2.17, 1.25, 0.86, and 0.21 ppm which matched

<sup>91</sup> Reference No. 81, 108, 110-112

<sup>92</sup> Reference Nos. 81, 108, 110-112

<sup>93</sup> Reference Nos. 108, 110-112

<sup>94</sup> Reference Nos. 75, 87, 90, 92, 93, 94, 101, 112

<sup>95</sup> Reference Nos. 98, 101, 103-104, 112

the consecutive series  $H_2(1/2)$ ,  $H_2(1/4)$ ,  $H_2(1/5)$ ,  $H_2(1/6)$ , and  $H_2(1/7)$ , respectively, and a higher ionizing molecular hydrogen recorded on the electrolysis gases collected in a hollow nickel cathode<sup>96</sup>,

85.) the observation of 1943  $cm^{-1}$  and 2012  $cm^{-1}$  peaks in the high-resolution (0.5  $cm^{-1}$ ) FTIR spectrum (490-4000  $cm^{-1}$ ) of  $KH^*I$  having a peak assigned to  $H^-(1/4)$  that matched the predicted frequencies of ortho and para- $H_2(1/4)$ <sup>97</sup>.

86.) the observation of the 1943/2012  $cm^{-1}$ -peak-intensity ratio of 3:1 in the high resolution (0.5  $cm^{-1}$ ) FTIR spectrum (1875-2060  $cm^{-1}$ ) of  $KH^*I$  which is characteristic of ortho-para hydrogen splitting wherein the ortho-para splitting of 69  $cm^{-1}$  matched that predicted<sup>98</sup>,

87.) the observation of rotational lines in the 145-300 nm region from atmospheric pressure 12.5 keV electron-beam excited argon-hydrogen plasmas where the unprecedented energy spacing of  $4^2$  times that of hydrogen established the internuclear distance as 1/4 that of  $H_2$  and identified  $H_2(1/4)$ <sup>99</sup>,

88.) the observation of emission from 12.5 keV-electron-beam-excited  $KH^*Cl$  having  $H^-(1/4)$  by NMR that matched the rotational emission lines of interstitial  $H_2(1/4)$  and further matched the rotational frequency of  $H_2(1/4)$  observed by FTIR and by electron-beam excitation of the argon-hydrogen plasmas<sup>100</sup>.

Applicant again respectfully demands that the Secret Committee consider and evaluate in detail all of this record evidence, which, to date, it has largely ignored. The scientific data disclosed in this extensive body of evidence was collected and peer-reviewed with great care by a group of highly qualified scientists capable of understanding every detail of Applicant's technology. The very least the Committee can do is to also carefully evaluate that data in detail, article by article, with an open mind so that Applicant is given a full and fair opportunity to present his case. If and when the

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<sup>96</sup> Reference Nos. 103-104.

<sup>97</sup> Reference Nos. 110-112.

<sup>98</sup> Reference Nos. 110-112.

<sup>99</sup> Reference Nos. 98, 101, 104, 110-112.

<sup>100</sup> Reference Nos. 111-112.



Committee finally does so, Applicant believes it will find that the evidence overwhelmingly proves the existence of lower-energy hydrogen in accordance with his disclosed invention.

If, on the other hand, the Committee should find true fault with any of that data on legitimate scientific grounds—not the kind of nitpicking Applicant has seen on theoretical grounds—it should communicate as much to afford Applicant the opportunity to respond. Such scientific give-and-take is the only way to advance the prosecution of this case.

Unfortunately, with continued prosecution of this and BlackLight's other applications, a far different pattern has emerged. The Committee continues to set arbitrary and capricious hurdles designed to avoid considering Applicant's conclusive experimental evidence and thereby block his patents from issuing. Each time Applicant clears one of these hurdles, the Committee merely raises the bar by setting new standards.

For instance, the Committee initially alleged that Applicant's disclosed hydrogen chemistry, which forms lower-energy hydrogen, related to the controversial concepts of "perpetual motion" and "cold fusion." When Applicant exposed those allegations as utter nonsense, the Committee quickly abandoned its indefensible position, arguing instead that BlackLight's lower-energy hydrogen technology violated unidentified laws of physics. Then, to cover up its failure to identify even a single physical law that was supposedly being violated, the Committee improperly placed the burden on Applicant to do so: "in order to establish enablement, applicant bears the burden of providing the accepted scientific laws wrong or incomplete." When Applicant showed that just the opposite is true—that Applicant's novel hydrogen chemistry complies with all physical laws, even at atomic and sub-atomic levels—the Committee once again backpedaled. The Committee then advanced vague assertions that Applicant's lower-energy hydrogen violated "ideas" of modern science and, later, that his technology contradicted "beliefs" in the scientific community.

The only consistency found throughout this myriad of contrived standards is the Committee's use of each to excuse it from fairly considering and evaluating Applicant's scientific evidence that lower-energy hydrogen does indeed exist. Instead, the

Committee prefers engaging in a theoretical debate to the exclusion of that evidence, pitting its favored quantum theory, with all of its far-fetched and disproved predictions, against Applicant's theory of classical quantum mechanics that correctly predicts the formation of lower-energy hydrogen.

Applicant has willingly engaged the Committee in this theoretical debate, and will continue to do so if necessary, even though the patent laws do not require that an inventor understand the precise theoretical basis for why his invention works. All the law requires is that he disclose his invention in sufficient detail to enable one of ordinary skill in the art how to practice it. Applicant has done precisely that and the Committee has failed in its burden to show otherwise.

Of course, the debate over these competing theories can go on indefinitely without resolution, which may be the Committee's strategy. Engaging in that intellectual exercise, however, will not—indeed cannot—definitively settle the question of whether practicing Applicant's disclosed hydrogen chemistry results in the formation of lower-energy hydrogen. Like any good theoretical debate, this one can only be tested and ultimately settled by fully and fairly evaluating the unprecedented amount of real-world experimental evidence Applicant has submitted conclusively confirming the lower energy states of hydrogen. Applicant has expended tens of millions of dollars amassing this experimental evidence. The least the Committee can do is properly consider it.

Instead, the Committee, consistent with its "allowance is not an option policy," has now taken an even more extreme erroneous position, based on the biased views of its most recent member, Dr. Souw, that all of Applicant's evidence actually "detract[s] from the central issue that the hydrino does not theoretically exist." [See, e.g., May 12, 2004 Advisory Action issued in U.S. App'n Ser. No. 09/669,877 at page 2 (emphasis added).] Out of the multitude of baseless arguments that the Committee has put forward, this one truly stands out as perhaps the most outrageous.

Applicant has spent enormous amounts of effort and money complying with the PTO's unlawful requirement that he publicly disclose his confidential data in peer-reviewed publications to prove the existence of lower-energy hydrogen. Now, incredibly, Applicant is being told that those efforts have been for naught since,

according to the Committee, "all of applicant's data cannot prove what is not theoretically possible." [Id. at page 2.]

The Committee's position, however, that it need not seriously analyze Applicant's scientific data because the existence of lower-energy hydrogen is so incredible as to be theoretically impossible—at least according to its misguided view of quantum mechanics—violates well-established patent laws and procedures. Indeed, the PTO's own procedures outlined in MPEP § 2107, p. 2100-31 require that the Examiner not start from the premise that an invention is "incredible," by mandating that:

[The Examiner] should not begin an evaluation of utility by assuming that an asserted utility is likely to be false, based on the technical field of the invention or for other general reasons. . . . A conclusion that an asserted utility is incredible can be reached only after the Office has evaluated both the assertion of the applicant regarding utility and any evidentiary basis of that assertion. The [Examiner] should be particularly careful not to start with a presumption that an asserted utility is, *per se*, "incredible" and then proceed to base a rejection under 35 U.S.C. 101 on that presumption.

When Applicant first criticized the Committee's error in refusing to consider Applicant's supporting evidence, under the presumption that the utility of his novel hydrogen technology is *per se* incredible, the Committee vehemently denied that it had ever taken the position that the existence of lower-energy hydrogen was impossible. For instance, the Committee's most prominent member, Dr. Souw, tried claiming that:

Contrary to Applicant's allegation on pg. 13, 1<sup>st</sup> full paragraph, lines 2-4, the PTO's view is not at all that the existence of lower-energy hydrogen were [sic] impossible, but instead, that (a) Applicant's invention is not supported by any experimental fact or evidence, and (b) the underlying theory (i.e., GUT/CQM) fails to support the invention, because it contains too many flaws. [Souw Appendix at p. 3 attached to the Committee's Final Office Action mailed August 24, 2004 in Applicant's U.S. Ser. No. 08/467,051 (emphasis added).]

After Applicant exposed the disingenuousness of those denials, the Committee has now at least finally dropped all pretenses and readily admits that it has dismissed the totality of Applicant's submitted scientific evidence based on the presumption that Applicant's pioneering technology is impossible. Applicant is hard pressed to imagine an approach to patent examination any more arbitrary and capricious than that.

As Applicant has consistently argued, the only way to settle the theoretical argument on whether lower-energy hydrogen actually exists is to properly evaluate the real-world evidence that Applicant and independent third parties have generated. For the Committee to now assert that this real-world evidence "detract[s] from the central issue that the hydrino does not theoretically exist" turns science on its head and is an embarrassment to a government agency charged with "promot[ing] the Progress of Science and useful Arts." [See U.S. Constitution, Art. I, Sect. 8, Clause 8.]

In the few isolated instances in which the Committee has addressed Applicant's evidence, it offers far-fetched reasons for dismissing it without a fair hearing, again demonstrating its arbitrary and capricious approach to examination of his cases. One prominent example occurred during the February 21, 2001 Interview held in all of BlackLight's then-pending lower-energy hydrogen applications, which was led by Examiner Vasudevan Jagannathan—one of the few Committee members Applicant has been able to successfully identify. At that interview, Applicant had a brief opportunity to present some of his scientific evidence, including spectroscopic data that is extraordinarily reliable in identifying chemical compositions. Such data amounts to a "chemical fingerprint" that cannot be seriously disputed. Despite the conclusiveness of that evidence, Examiner Jagannathan dismissed it out of hand as nothing more than "a bunch of squiggly lines."

To put the absurdity of that comment in context, the PTO rationalized its withdrawal of BlackLight's five allowed patent applications, in part, by citing a January 12, 2000 article written by Dr. Robert Park, spokesman for one of Applicant's main competitors, the American Physical Society (APS). [March 22, 2000 Decision at page 7 (Attachment G)] In that article, Dr. Park made the following startling statements:

The energy states of atoms are studied through their atomic spectra—light emitted at very specific wavelengths when electrons make a jump from one energy level to another. The exact prediction of the hydrogen spectrum was one of the first great triumphs of quantum theory; it is the platform on which our entire understanding of atomic physics is built. The theory accounts perfectly for every spectral line.

There is no line corresponding to a "hydrino" state. Indeed there is no credible evidence at all to support Mills' claim. [See Attachment J (emphasis added)]

The incredible irony here—one that cannot be easily overlooked—highlights once again the extreme arbitrary and capricious approach the Committee has taken in examining this and other BlackLight applications. There is no question that the vitriol espoused by Dr. Park in his cited *Post* article was, at least, partially responsible for the PTO's suspect withdrawal of the five allowed BlackLight applications from issue. And yet, despite the fact that the very article the PTO relies upon to deny Applicant his patents recognizes that spectroscopic data is extraordinarily reliable—indeed, the “platform on which our entire understanding of atomic physics is built”—the Committee nonetheless continues to cavalierly ignore or dismiss that same data when submitted by Applicant.

Out of exasperation, Applicant queried Examiner Jagannathan during the February 21, 2001 Interview as to what type and quality of evidence would convince him that lower-energy hydrogen exists. In response, the Examiner required that Applicant publicly divulge confidential information by publishing his experimental evidence in peer-reviewed scientific journals for that evidence to be considered reliable. As detailed above, Applicant has more than met this newly created “publication” standard for considering his experimental evidence by submitting over 100 scientific papers for publication, even though the PTO's rules and procedures impose no such requirement. So far, over 60 of these papers have completed and passed the peer-review process conducted by highly qualified Ph.D. referees.

Applicant's experimental evidence has been extensively peer-reviewed and published in the following esteemed journals:

- Applied Physics Letters
- Chemistry of Materials
- Electrochimica Acta
- European Journal of Physics D
- European Physical Journal: Applied Physics
- Fusion Technology Journal of New Materials for Electrochemical Systems
- IEEE Transactions on Plasma Science
- International Journal of Hydrogen Energy

Journal of Applied Physics<sup>101</sup>  
Journal of Material Science  
Journal of Molecular Structure  
Journal of Optical Materials  
Journal of Plasma Physics  
Journal of Physics D: Applied Physics  
Journal of Quantitative Spectroscopy and Radiative Transfer  
Journal of New Materials for Electrochemical Systems  
New Journal of Physics  
Physics Essays  
Plasma Sources Science and Technology  
Solar Energy Materials & Solar Cells  
Thermochimica Acta  
Vibrational Spectroscopy

Additionally, Applicant's experimental evidence has been submitted for peer-review and publication in the following esteemed journals:

Acta Physica Polonica A  
AIAA Journal  
Anuoles de la Fondation Louis de Broglie  
Brazilian Journal of Physics  
Canadian Journal of Physics  
Central European Journal of Physics  
Chemical Engineering Science  
Contributions to Plasma Physics  
Current Applied Physics  
Europhysics Letters  
Fizika A  
Foundations of Science  
Journal of Applied Spectroscopy

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<sup>101</sup> Applicant notes that the *Journal of Applied Physics* is the very same journal cited by the Committee as credible evidence that Dr. Souw, one of its premier members, is supposedly qualified to evaluate Applicant's novel hydrogen technology. [See *infra*.]

Journal of Mathematical Physics  
Journal of Materials Research  
Journal of Physical Chemistry A  
Journal of Physical Chemistry B  
Journal of Vacuum Science & Technology A  
Materials Characterization  
Materials Chemistry and Physics  
New Journal of Chemistry  
Physical Review B  
Physica Scripta  
Spectrochimica Acta Part B: Atomic Spectroscopy  
Thin Solid Films  
Vacuum

Once again, however, the Secret Committee has raised the bar to patentability by arbitrarily and capriciously ignoring this vast body of evidence that it required Applicant to submit. The Committee apparently believes that its anonymous members are better qualified than the numerous skilled PhD's who peer-reviewed and approved the contents of Applicant's articles confirming the existence of lower-energy hydrogen.

The PTO's mishandling of the experimental evidence of record in this case is but one of several improper actions that have adversely effected Applicant's patent rights. Others include:

- (1) illegally withdrawing or threatening to withdraw other copending BlackLight patent applications from issue, after initially allowing all claims, under highly suspicious circumstances that suggest likely interference by BlackLight's competitors;
- (2) improperly examining this application by Secret Committee, effectively denying Applicant the right to confront the persons involved in that examination, to assess their qualifications and biases, and to ascertain whether those persons include BlackLight's competitors or other improper outside influences, in breach of PTO confidentiality requirements; and
- (3) refusing reasonable requests by Applicant and five U.S. Senators to divulge information relating to the events that triggered the PTO's withdrawal action,

and the identity of all PTO employees and non-PTO personnel involved in examining BlackLight's applications.

These improper actions bear directly upon the prosecution of BlackLight's pending applications, yet Applicant's good faith efforts to discuss and resolve these and other outstanding issues have been either ignored or rejected out of hand. One of Applicant's many overtures was communicated directly to then PTO Director James E. Rogan in a letter dated December 21, 2001, from BlackLight board member Dr. Shelby T. Brewer. Dr. Brewer received his Ph.D. in Nuclear Engineering from M.I.T. and served as Assistant Energy Secretary in the Reagan administration. [See Attachment A]

As stated in his letter, Dr. Brewer's reasons for appealing to Director Rogan were motivated not only by his fiduciary duty to protect BlackLight's interests, but also by a sincere desire to avoid unnecessary embarrassment to the PTO over these lingering issues if left unresolved. Dr. Brewer appealed for a meeting with Director Rogan in an attempt to bring some closure to this matter in a way that might mutually benefit both sides.

Despite the urgency of his plea, Dr. Brewer waited over four months before finally receiving a response to his request for a meeting. In a curt letter dated April 24, 2002, from the Director's Chief-of-Staff, Jason C. Roe, the PTO advised: "We appreciate your interest in this matter, but, unfortunately, must decline your request for a meeting due to the fact that the USPTO is not in a position to discuss the issue at the present time." [See Attachment A] The PTO's response, however, merely begs the question: if not now, when will it be in a position to have these discussions?

This negative response, while disappointing, was hardly surprising. In refusing to meet with Applicant, the PTO continues to treat prosecution of this and BlackLight's other copending cases as an adversarial proceeding. While the PTO may believe it is justified in shrouding its untoward actions under a cloak of secrecy and remaining answerable to no one, that approach does little to preserve public confidence in the patent process. Only by openly engaging Applicant in mutually beneficial discussions of all the issues in this case can the PTO ever hope to achieve that worthy goal. Applicant



therefore implores the PTO to reconsider its policies and adopt a more flexible and cooperative approach by agreeing to meet with Applicant to discuss the handling of this and other pending BlackLight applications before taking any further action.

Perhaps the PTO sees no need to modify its approach, buoyed by the Federal Circuit's June 28, 2002 Decision upholding its withdrawal action that cancelled issuance of BlackLight's allowed patent applications. See *BlackLight Power, Inc. v. Director James E. Rogan*, 63 USPQ2d1534 (Fed. Cir. June 28, 2002) [Attachment B]. The Federal Circuit ruled, among other things, that an "emergency situation" trumped the controlling regulation requiring the PTO to determine the unpatentability of one or more claims before it withdrew the '294 application from issue so that the PTO's mere "concern" over patentability provided adequate basis for the withdrawal. That Decision, aside from the fact that it is erroneous,<sup>102</sup> does not even begin to resolve other issues that touch on the merits of this case.

One such issue is how this alleged "emergency situation" arose in the first place, *i.e.*, how the PTO became aware of BlackLight's issued U.S. Patent No. 6,024,935 (the '935 patent) that supposedly raised "concerns" about other pending applications. That

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<sup>102</sup> Applicant believes that the Federal Court's opinion is erroneous due, in part, to its misreading of a concurring opinion of one Justice in a 38-year-old Supreme Court case to support its holding that this supposed "emergency situation"—a finding that was not supported by the record or even argued by the PTO—justified the PTO's withdrawing BlackLight's copending '294 application from issue on February 17, 2000, after payment of the issue fee. See *BlackLight Power* at page 7 citing *Baltimore & Ohio Railroad Co. v. United States*, 386 U.S. 372, 421 (1964) (Brennan, J., concurring) (recognizing the importance of leaving the Interstate Commerce Commission (ICC) great flexibility to deal with emergency situations to avoid serious damage to the national transportation system, but finding no pressing need that justified the ICC's action). The Federal Circuit stretched that case way beyond the limits of Supreme Court precedent that requires government agencies to strictly follow statutory and regulatory guidelines.

Incredibly, at oral argument, the PTO did not even suggest that an emergency situation had forced it to withdraw this application from issue on February 17, 2000. To the contrary, PTO Solicitor John M. Whealan argued that no withdrawal—emergency or otherwise—occurred on that date and admitted that, if the Court found otherwise, his case would be seriously compromised. This was because, at that time, the PTO could not locate the patent file and admittedly could not have made a determination of unpatentability of one or more claims as required by the controlling regulation. See 37 C.F.R. § 1.131(b)(3); MPEP § 1308 (7<sup>th</sup> Ed., Rev. 1, Feb. 2000). To avoid an adverse ruling, Solicitor Whealan sought refuge outside the administrative record, suggesting for the first time that the PTO had used the wrong form in mistakenly notifying Applicant on February 17 that his application had been withdrawn. Then, again without evidentiary support, the Solicitor tried to convince a skeptical Court that Director Kepplinger, in consultation with the Examiner, had made an unpatentability determination sometime later, after Applicant had voluntarily supplied the PTO with a copy of the application—hardly an emergency situation if it were true.

issue apparently was not important to Associate Solicitor Kevin Baer who defended the PTO's conduct by arguing to the District Court: "I would even say, Your Honor, you could imagine in our head any scenario of how we learned about it. A blimp flying over us. It doesn't matter, because what matters, Your Honor, is the decision [to withdraw] itself." [May 22, 2000 Transcript at 22 (Attachment K, Tab E)]

Judge Sullivan, however, was apparently unimpressed by those comments, noting in footnote 10 of his opinion that he was "troubled by several steps in the PTO's process" and advising the PTO to "examine its patent issuance process so that their normal operations are not compromised by such seemingly suspicious procedures." [See 109 F.Supp. 2d at 53, n.10 (See Attachment L)]

While the PTO may be unconcerned how it learned of the '935 patent, Applicant considers that information critically important. If, for instance, competitors were somehow involved in events leading to the withdrawal of BlackLight's allowed applications and, perhaps, in the subsequent prosecution of those and other applications, that information would relate directly to the credibility of the rejections entered in those cases, including this one. Applicant therefore renews his request for a full accounting of how, out of the thousands of patents the PTO issues every week, his '935 patent came to its attention, thus leading to the withdrawal of BlackLight's allowed applications.

Applicant believes that concerns over outside influences on the prosecution of his applications are fully justified. Following the PTO's withdrawal action, counsel immediately investigated the facts and circumstances surrounding that action by questioning various PTO personnel. In discussions with Director Esther Kepplinger, she admitted to counsel that the withdrawal was a reaction to perceived heat—a "firestorm" as she put it—the PTO had received from an undisclosed outside source. Director Kepplinger further indicated that the withdrawal occurred only after BlackLight's '935 patent had been brought to the attention of then-Director Q. Todd Dickinson by Gregory Aharonian, another PTO outsider well known for publicly attacking issued U.S. patents.<sup>103</sup>

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<sup>103</sup> See Applicant's February 28, 2000 letter to Director Kepplinger documenting telephone and personal conversations between her and Applicant's counsel regarding improper outside influence that precipitated

Director Keplinger's revelations are truly disturbing in that they describe what is essentially a newly created non-statutory reexamination procedure for opposing the issuance of patents never envisioned by Congress. *Compare* 35 U.S.C. §§ 301-307 (patent reexamination statutes).

Following the PTO's drastic withdrawal action, Applicant discovered other reliable information suggesting the likelihood of outside interference with BlackLight's patent applications and breaches of the PTO's duty to maintain the confidentiality of those applications. Applicant initially learned that Dr. Peter Zimmerman, former Chief Scientist for the State Department, had published an Abstract of an upcoming speech to the American Physical Society (APS)—a BlackLight competitor—boasting that his Department and the Patent Office "have fought back with success" against BlackLight. [See Attachment K, Tab C] In conversations with BlackLight's counsel, Dr. Zimmerman admitted that he had received information concerning BlackLight's applications through e-mails from Dr. Robert Park, spokesman for the APS, who told him of a contact in the PTO referred to by Dr. Park as "Deep Throat" with access to confidential patent information. [See Attachment K, Tab C]

An *APS News Online* bulletin, dated September 2002, suggests that Dr. Park is maintaining his questionable PTO contacts, apparently with the agency's blessing:

#### **APS E-Board Passes Resolution on Perpetual Motion Machines**

The APS Executive Board approved a resolution at its June 2002 meeting in Annapolis, MD, affirming the fraudulent nature of claims of perpetual motion machines.

The resolution was deemed necessary because of a recent increase in patent applications for such devices. Robert Park, APS Director of Public Information and author of the weekly electronic newsletter, "What's New," reported that the US Patent Office has received several patent applications for perpetual motion machines during the first six months of this year alone. [Park's 2000 book, *Voodoo Science*, devoted considerable space to the phenomenon of such devices throughout history.] The text of the APS resolution follows.

The Executive Board of the American Physical Society is concerned that in this period of unprecedented scientific advance, misguided or fraudulent claims of perpetual motion machines and other sources of unlimited free energy are proliferating. Such devices directly violate the most fundamental laws of nature, laws that have guided the scientific progress that is transforming our world.

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[Attachment Q (emphasis added)] Dr. Park's knowledge of the number of pending patent applications filed in the PTO directed to a particular subject matter—information that is supposedly kept confidential—raises additional questions as to his activities in interfering with the prosecution of U.S. patent applications.<sup>104</sup>

Of course, this should come as no surprise since Dr. Park has basically admitted his direct involvement in BlackLight's patent affairs, as evidenced by the September 6, 2002 issue of *What's New* he authored and published on the APS website:

The status of BlackLight Power's intellectual property is fuzzier than ever. BLP was awarded Patent 6,024,935 for "Lower-Energy Hydrogen Methods and Structures," a process for getting hydrogen atoms into a "state below the ground state". . . . You might expect these shrunken hydrogen atoms, called "hydrinos," to have a pretty special chemistry. Do they ever! Indeed, a second patent application titled "Hydride Compounds" had been assigned a number and BLP had paid the fee. Several other patents were in the works. That's when things started heading South. Prompted by an outside inquiry (who would do such a thing?), the patent director became concerned that this hydrino stuff required the orbital electron to behave "contrary to the known laws of physics and chemistry." The Hydride Compounds application [the '294 application] was withdrawn for further review and the other patent applications were rejected. [September 6, 2002 Online Newsletter of Dr. R. Park, *What's New* (Attachment C) (emphasis added)]

Dr. Park's startling admission was confirmed two weeks later in the September 20, 2002 issue of the *Online Newsletter* published by the James Randi Educational

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<sup>104</sup> Not coincidentally, the Committee initially attacked the operability of Applicant's invention by mischaracterizing it as a "perpetual motion machine" and, therefore, *per se* unpatentable. The Committee quickly withdrew that line of attack after Applicant showed it was completely lacking in any merit.

Foundation (JREF). In it, James Randi gleefully boasted about Dr. Park's contacting the Patent Office with the express purpose of sabotaging Applicant's patent rights:

But why, hard on the heels of re-examining other questionable patents (see three weeks ago on this page), would the Patent Office have happened upon this particular one [BlackLight's withdrawn '294 application], when there are so many in this category? The secret can be inferred from Bob Park's weekly column, where we find: "Prompted by an outside inquiry (who would do such a thing?) . . ." That rascal!

The very fact that the Patent Office has paid heed to the complaints that Park, the JREF, and others have made, speaks well for rationality. Let's hope that we can look forward to many quack devices and systems being re-evaluated. Let's see a lot more of this "extraordinary action" from the Director. As for BlackLight Power, says Park, "Their long-awaited IPO may have to wait a little longer." [September 20, 2002 Online Newsletter of the JREF, *Swift* (Attachment C) (emphasis added)]

Despite all of this overwhelming incriminating evidence of improper outside interference by competitors with an administrative patent proceeding—a possible criminal offense—the PTO continues to ignore this matter.

Apparently, this is not the first time that Dr. Park, James Randi and PTO officials have been embroiled in a patent controversy such as this one involving improper interference with a patent proceeding. Less than a year before Applicant's five allowed applications were withdrawn from issue in February 2000, the PTO was caught up in another scandal of sorts involving the issuance of U.S. Patent Nos. 5,748,088 and 6,011,476, granted on a device that can identify the obscured location of living entities. Following issuance of the '088 patent, Dr. Park published in his *What's New* newsletter inaccurate, disparaging remarks, which were picked up by James Randi on his JREF website, concerning the operation and reliability of the claimed invention. [See Attachment H] An article published in *Science Magazine* during the pendency of the '476 patent also reported on the controversy and the involvement of Sandia National Labs (SNL) in the testing of the device. [Attachment D]

SNL's involvement and the disclosure of confidential information to David Voss, the author of the *Science* article, was itself the subject of some controversy and resulted in the issuance of an internal PTO memorandum that was placed in the '476 patent file.

In that memorandum, the PTO felt compelled to reiterate its policy forbidding PTO employees from making public disclosures concerning pending patent applications:

PTO MEMORANDUM FOR ALL EMPLOYEES: MEDIA CONTACT POLICY

Posted Date: 06/25/99  
Removal Date: 07/06/99

UNITED STATES DEPARTMENT OF COMMERCE  
Patent and Trademark Office  
ASSISTANT SECRETARY AND COMMISSIONER OF PATENTS AND  
TRADEMARKS  
Washington, D.C. 20231

June 22, 1999

99-42

MEMORANDUM FOR All Employees

FROM: Acting Assistant Secretary of Commerce and Acting  
Commissioner of Patents and Trademarks

SUBJECT: Media Contact Policy

Since a memorandum on this subject was first issued several years ago, thousands of new employees have joined the PTO. Therefore, it is a good time to reiterate PTO policy concerning employee contact with members of the media including, but not limited to, those in print, broadcast, cable, and online publications.

All requests, including telephone and e-mail, from members of the media for interviews, tours, and appearances should be directed to the Office of Public Affairs (Richard Maulsby or Brigid Quinn). Public Affairs will then determine the appropriate Office response for such requests and arrange for all interviews and any other meetings with the media. A member of the Public Affairs staff may attend interviews and meetings.

This policy applies only to contact with the media, not to interactions with customers. Any questions about media contact should be directed to the Office of Public Affairs at 305-8341.

Additionally, MPEP section 1701 and TMEP section 1801 specify that Office personnel should not comment on the validity or enforceability of any U.S. patent or trademark registration. These sections also caution employees about answering other particular inquiries concerning U.S.

patents or trademark registrations. Any questions on this policy should be directed to your supervisor or to the MPEP Editor at 305-8813 for patents or to the Office of the Assistant Commissioner for Trademarks at 308-8900. [Attachment E]

Curiously, SNL is where Dr. Park previously served as head of its Surface Physics Division, leading Applicant to wonder whether SNL, or any of its sister labs, have had any similar involvement in the examination of this and other BlackLight applications. Applicant's curiosity on this point is further heightened by the fact that Examiner Bernard Souw, a former employee with Brookhaven National Labs, is a premier member of the Secret Committee who has been engaged in the examination of BlackLight's patent applications for some time now. [See, e.g., App'n Ser. No. 09/513,768] As discussed below, Examiner Souw's activities as lead scientist for a company he owns in competition with BlackLight, while simultaneously examining BlackLight's patent applications, raises a genuine conflict of interest, thus adding further cause for concern over outside interference with Applicant's patent rights.

If, as Applicant suspects, the PTO has conferred with others having ties to the APS, like Dr. Park or Dr. Zimmerman, or to other BlackLight competitors in withdrawing or rejecting BlackLight's applications, that information would be highly relevant and thus must be disclosed. Obviously, knowing the identity and potential biases of all persons providing input or otherwise involved in rejecting BlackLight's applications, especially those with competing interests, bears directly on the credibility of those rejections. This point could not have been made more clear than the Committee's adoption of Examiner Souw's biased views in formulating its rejections in this case.

Applicant has, on numerous occasions, disclosed to PTO officials information relating to Dr. Park's undermining of BlackLight's patent rights, as relayed in Dr. Brewer's December 21, 2001 letter to then PTO Director Rogan, only to be ignored. [Attachment A. See also, for example, January 19, 2001 Letter to Director Kepplinger (Attachment K)] As Dr. Brewer explained in his letter, BlackLight is obviously concerned, among other things, that the PTO may have once again breached its duty to maintain confidentiality of U.S. patent applications under 35 U.S.C. § 122, 18 U.S.C. §

2071, 37 C.F.R. § 1.14, and M.P.E.P. § 101. The PTO's curt statement that it is "not in a position to discuss the issue at the present time" does little to allay those concerns.

Dr. Brewer further expressed in his letter distress over the suspected compromise of Applicant's patent rights to his novel hydrogen chemistry by a group of physicists with a vested interest in maintaining federal funding for projects based on a competing scientific theory and concern that those physicists continue to exert improper influence over the prosecution of BlackLight's pending applications. Those suspicions are only fueled by continued PTO silence on these issues while it undercuts Applicant's patent rights based on statements of competitors like Dr. Park. For instance, in the March 22, 2000 Decision justifying its withdrawal of Applicant's allowed patent applications, the PTO relied, in part, on a *Washington Post* article written by Dr. Park only slightly more than a month prior to the withdrawal:

While petitioner in the accompanying letter points to favorable testimonials from scientists and entrepreneurs regarding the "revolutionary technology" that the instant application is asserted to embody, this does not establish that either the Director, Technology Center 1700, or the Director, Special Programs Law Office, committed reversible error, nor that the Notice should be withdrawn. In contrast, mainstream newspapers have reported this same "revolutionary technology" is accompanied by controversy in the scientific community. See Baard et al., Scientists and entrepreneurs have lots of ideas about new sources of energy; some may even be practical, *Wall St. J.*, Sept. 13, 1999, at R16; **Park, Perpetual motion; still going around, *Washington Post*, Jan. 12, 2000, at H3.** [March 22 Decision at 7 (Attachment G)]

Applicant is naturally skeptical that this timing was simply a coincidence. Regardless, the mere fact that the PTO would rely on any competitor to "bad-mouth" BlackLight's technology is troubling. That it relied on Dr. Park of all people, known for conducting "hatchet jobs" on new technologies that threaten federal funding for the physicists he represents, is contemptible.

The same *Washington Post* that ran Dr. Park's libelous article rebuked its less than credible author in a subsequent article confirming his reputation for engaging in what it described a "search-and-destroy mission" against inventors and scientists who seek to advance the bounds of science. [See Article dated June 25, 2000 (Attachment M)] To quote the article's exact words, "Park's anger permeates his rebuttals, which



border on character assassination." Noting that "thoroughness is not Park's strong suit," the article goes on to suggest that his intentions may be less than honorable:

Park's failure to gather first-hand data is unfortunate, but his selective omissions are far more serious. In at least one case, he violated basic principles of journalism and science itself by apparently suppressing information that conflicts with his foregone conclusion. . . . Such tactics are reminiscent of the behavior of a zealous DA who is so convinced that a suspect is guilty that he feels entitled to withhold some information from the jury.

Dr. Park's competitive motives in attacking BlackLight's novel hydrogen chemistry, and thereby undermining its patent rights, are clear, as further recognized by the *Post* article in its description of Dr. Park as "a Washington lobbyist and PR flack for the American Physical Society." The article goes on to warn of the serious effects a rush to judgment can have without first-hand review of experimental evidence:

This is a serious matter, since even poorly documented vitriol can jeopardize a scientist's reputation and future funding if it is disseminated with the complicity of a respected organization such as the American Physical Society.

Incredibly, in rationalizing its withdrawal action, the PTO pays tribute to a "hatchet man" like Dr. Park, who represents a competitor intent on sabotaging BlackLight's patent rights, by citing his hostile statements against BlackLight. Yet, in explaining the issuance of BlackLight's '935 patent, the PTO publicly denigrates its entire examining corps, previously known for their careful study of experimental evidence in deciding whether to issue U.S. patents:

[P]atent examiners do review [patent applications]. Unfortunately, patent examiners are swamped and sometimes things slip through. [Statement of Associate Solicitor Baer in *BlackLight Power, Inc. v. Q. Todd Dickinson*, May 22, 2000 Tr. at 7 (Attachment K, Tab A)]

[E]xaminers are under tremendous pressure to produce work, and if they're going to approve [an application], they just approve it and kind of let it out the door. [May 22, 2000 Tr. at 48 (Attachment K, Tab A)]

As Dr. Brewer pointed out in his December 21, 2001 letter to Director Rogan, the PTO's outrageous public statements violate 35 U.S.C. § 282, under which statute all issued U.S. patents are presumed to be valid:

### **Presumption of validity; defenses**

A patent shall be presumed valid. Each claim of a patent (whether in independent, dependent, or multiple dependent form) shall be presumed valid independently of the validity of other claims; dependent or multiple dependent claims shall be presumed valid even though dependent upon an invalid claim. The burden of establishing invalidity of a patent or any claim thereof shall rest on the party asserting such invalidity.

Underlying this fifty-year-old statutory presumption of validity is the premise of administrative regularity, which presumes that well-trained examiners with expertise in their respective fields properly carry out their examination duties by issuing only valid patents. See, e.g., American Hoist & Derrick Co. v. Sowa & Sons, Inc., 725 F.2d 1350, 1359 (Fed. Cir. 1984). This presumption was, in fact, confirmed by the capable work of Examiners Langel and Kalafut who, with over 50 years of experience between them, examined and allowed Applicant's '935 patent, along with BlackLight's withdrawn applications.<sup>105</sup>

As succinctly stated in Dr. Brewer's letter, Solicitor Baer's statements on behalf of the PTO should be alarming to just about everyone, with the possible exception of accused patent infringers, and most certainly do not reflect well on an agency charged with maintaining the integrity of the patent system. Applicant felt that a meeting with Director Rogan to secure a retraction of those statements would be mutually beneficial to both sides. Yet once again, inexplicably, the PTO was not, and presumably is still not, prepared to discuss this issue.

These and other unfair assaults on Applicant's patent rights leave him to ponder: What would motivate the PTO to conduct itself with such total disregard for U.S. patent laws and regulations governing its administrative authority just to attack this one Applicant?

Applicant's fear is that these attacks may be attributable to competitors, like Dr. Park, who are coordinating an organized smear campaign to discredit BlackLight's technology. That fear is only heightened by the PTO's hiding behind strained

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<sup>105</sup> The Examiners initially rejected all claims in these cases, but after conducting five lengthy personal interviews with Applicant and carefully considering Applicant's experimental evidence, they ultimately allowed those claims.

theoretical arguments as an excuse for refusing to fairly evaluate Applicant's experimental evidence, while using its Secret Committee to issue anonymous rejections in this and other BlackLight applications. Dr. Brewer also brought these issues to Director Rogan's attention as an agenda item for a meeting that, unfortunately, has never taken place.

Applicant has a right to know the identity and qualifications of all persons providing input to, or otherwise participating in, the examination process. This information bears directly on the credibility of the rejections that have been entered in this and other BlackLight applications. For instance, if Dr. Park or any of his physicist cronies have been consulted in denying Applicant his patent rights, it would certainly explain the arbitrary and capricious handling of the experimental evidence of record in those cases.

Particularly germane is the identity of all persons responsible for, or otherwise involved in, creating the Office Actions, Attachments, and Appendices that make up the record in this application and other BlackLight cases. To this day, the Committee has refused, without any adequate explanation, to provide this vital information to the detriment of Applicant.

Furthermore, Applicant is entitled to know which PTO officials are ultimately responsible for analyzing Applicant's scientific data evidencing the existence of lower-energy hydrogen, and which officials have the final authority to decide the fate of BlackLight's applications. The Committee's unfair refusal to divulge that information has also seriously handicapped Applicant's ability to effectively respond to and overcome the rejections of record.

For instance, Applicant has been stymied on numerous occasions in attempts to discover the basis for various positions articulated by the Committee, or the status of certain actions it has taken. Seldom are the Examiners of record, who are mere signatories to the Committee's handiwork, or their immediate supervisors, able to give any useful guidance on those subjects, either because they have no authority to do so and cannot divulge who does or, in some cases, they do not know who even has custody of the patent file so as to investigate the answer to a particular question.

Knowing who is responsible for analyzing the record evidence would also allow Applicant to assess that person's qualifications, as compared to those Ph.D. scientists who have peer reviewed the published experimental evidence confirming lower energy states of hydrogen. Equally important, by knowing who has authority to issue BlackLight's applications, Applicant can more easily ascertain and satisfy the patentability standards being applied in rejecting claims to his novel hydrogen technology.

Illustrating this last point, Applicant attempted to force the Secret Committee to set reasonable standards by which his data could be accepted as reliable proof by requesting the personal Interview that was held on February 21, 2001. Of course, to effectively determine the standards being applied against Applicant, he first had to identify the person(s) responsible for setting those standards.

Applicant, however, was only partially successful in that effort. Prior to the February 21 Interview, Applicant's counsel uncovered the identity of only one Committee member, Examiner Vasu Jagannathan, who played a role in rejecting BlackLight's applications. Incredibly, Examiner Jagannathan initially denied any such involvement, accurately noting that his name did not appear anywhere in the record. He therefore refused counsel's explicit request that he attend the upcoming Interview. Only after counsel wrote to a high-level supervisor demanding that Examiner Jagannathan attend did counsel receive confirmation that the Examiner was "directly involved in the creation of the Office Action" to be discussed at the Interview and that he would indeed attend. [See January 19, 2001 letter to Director Esther Kepplinger (Attachment K) and February 12, 2001 Letter from Director Jacqueline M. Stone (Attachment N)]

Examiner Jagannathan confirmed his direct involvement by leading the Interview discussions. The Examiner's participation afforded Applicant an opportunity to assess his qualifications to examine and evaluate the experimental evidence of record. Applicant was astonished to hear Examiner Jagannathan basically admit he was unqualified to do so based on several of his comments. One of those comments, as discussed previously, included his characterization of Applicant's highly reliable spectroscopic data confirming lower energy states of hydrogen as a "bunch of squiggly lines."

When pressed for guidance on what standards he used to evaluate Applicant's scientific data and to decide whether to issue his patents, Examiner Jagannathan would not elaborate. Rather, he proposed a new standard requiring Applicant to submit and publish his data in peer-reviewed journal articles before he would give it serious consideration. Despite strenuous objections to this newly minted standard requiring public disclosure of confidential information, Applicant has nonetheless worked diligently to comply with it.

Over the subsequent years, Applicant has used vast resources to present experimental evidence of lower energy states of hydrogen—much of it generated by independent third parties—in over 60 peer-reviewed articles published in the prestigious scientific journals mentioned above. Despite this significant accomplishment, the Committee, true to form, has essentially ignored that published evidence.

Even more impressive, Applicant has successfully met the Committee's new "publication" standard despite attempts by another of Applicant's main detractors, Dr. Zimmerman, to undermine that effort. [See Attachment H] Applicant's discovery that Dr. Zimmerman has been contacting various journals to dissuade them from publishing Applicant's articles is especially alarming given that the Committee has relied on non-peer reviewed statements by him—statements that were posted to an internet bulletin board of all places and that he readily admits are biased—to reject BlackLight's applications.

If, as Applicant suspects, the Committee has cooperated with Dr. Zimmerman, or other such biased individuals, in denying Applicant his patent rights, while those same individuals have worked behind the scenes to undermine Applicant's compliance with the Committee's concocted publication requirement, then again, that information is highly relevant and should be disclosed without further delay. Such a scenario would be entirely consistent with the prior admission by Dr. Zimmerman that while he served as Chief Scientist for the State Department, his Department and the PTO "fought back with success" against BlackLight. [See Attachment K, Tab C.]

Applicant is hardly surprised by his inability to break the PTO's code of silence on the suspicious handling of BlackLight's applications given that the PTO is also stonewalling similar inquiries from five U.S. Senators—four of whom requested that

Senator Patrick Leahy, Chairman of the Judiciary Committee overseeing the PTO, and/or Commerce Secretary Donald Evans, look into this matter. [See letters to and from Senators Max Cleland, Robert Torricelli, Jon Corzine, Ron Wyden, and Gordon Smith (Attachment O)] The PTO's continued refusal to cooperate in response to Senate inquiries suggests that, perhaps, it has something to hide.<sup>106</sup>

If the PTO looks to the Federal Circuit's June 28, 2002 Decision for license to continue its unfair and dilatory prosecution through secret examination, it will not find it. Indeed, Judge Newman, in rationalizing her ruling, incorrectly assumed that the PTO would fairly and expeditiously prosecute BlackLight's applications:

Such action must of course be reasonable under the circumstances and rare in occurrence, lest the emergency become the rule. But when necessary in order to fulfill the PTO's mission, with safeguards to the interests of the applicant including fair and expeditious further examination, we agree with the district court that the action taken is a permissible implementation of the statute and regulation. [See *BlackLight Power* at pages 1537 (Attachment B) (emphasis added).]

Nothing could be further from the truth. As documented by Applicant, the PTO's prosecution of BlackLight's applications has been nothing short of hostile and its attempt to hide the mistreatment of Applicant behind the authority of a Secret Committee only exacerbates the unfairness of those actions. Because this untenable situation has failed to provide the safeguards to the interests of Applicant, including the fair and expeditious further examination contemplated by the Federal Circuit in its Decision, Applicant has herein requested an equitable remedy that the PTO immediately issue all five of the withdrawn BlackLight applications that gave rise to that Decision. [See Demand for Information and Redress, *infra*.]

Applicant strongly urges the PTO to break its silence and to engage in an open and honest discussion of these issues that continue to plague the examination of

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<sup>106</sup> In the PTO's reply to the Senators' inquiry letters, Robert L. Stoll, Administrator for External Affairs, contended that any comments in response to those inquiries would be "inappropriate" because of the then-pending appeal to the Federal Circuit in *BlackLight Power Inc. v. Dickinson*, Civ. No. 00-0422 (D.D.C.). [See Attachment O] Putting aside the fact that the issues then on appeal had absolutely nothing to do with the points of inquiry, this contrived excuse has gone stale as the Federal Circuit decided that case many years ago in June 2002. [See Attachment B] By its own statements, nothing now prevents the PTO from cooperating with the U.S. Senate regarding the administrative irregularities brought to its attention.

BlackLight's pending applications. To this end, Applicant renews his earlier commitment, as expressed in Dr. Brewer's December 21, 2001 letter, to meet with the PTO Director and/or any other government officials, anywhere, anytime, to resolve these outstanding issues. Applicant sincerely hopes that the Director will likewise commit himself to achieving the same objective so that a fair and expeditious prosecution of all of BlackLight's applications that safeguards Applicant's interests, as envisioned by the Federal Circuit, can be achieved with mutually beneficial results.

Part of that forward movement should include a complete and proper consideration of Applicant's overwhelming experimental evidence confirming the utility and enablement of Applicant's novel hydrogen technology. In view of that evidence, Applicant submits that the rejections under 35 U.S.C. §§ 101 and 112 are misplaced and should be withdrawn, and that the present application is in condition for allowance.

**Discussions Held And Agreements Reached  
During The February 11, 2003 Interview**

The above-mentioned problems associated with the Secret Committee's examination of this and other BlackLight applications can be summarized as follows based on its failure to:

- (1) identify all persons from within and outside the Patent Office who contributed to, or were otherwise involved in, withdrawing or rejecting BlackLight's applications;
- (2) identify those persons having ultimate authority to analyze the vast body of experimental evidence demonstrating the existence of lower energy states of hydrogen and, based on that analysis, for deciding whether to issue patents on Applicant's novel hydrogen technology;
- (3) establish and apply consistent patentability standards and guidelines by which that patentability decision is to be made; and
- (4) properly analyze the evidence of record—now published, or to be published, in over 60 peer-reviewed journal articles—that the Committee required Applicant to submit.

The Committee merely perpetuated those failures in its previous Office Actions by dismissing, without serious analysis, Applicant's submitted data evidencing lower energy states of hydrogen. Frustrated by the Committee's inaction, but still determined to get a fair and expeditious hearing, Applicant requested and received the courtesy of another personal Interview, held February 11, 2003, to present his evidence and to discern the standards by which the ultimate decision-maker would be evaluating it.<sup>107</sup>

To that end, Applicant repeatedly requested that Examiner Jagannathan attend the Interview, since he had led the prior Interview held February 21, 2001, and, despite attempts to keep his identity secret, he was the only person known at the time to have been directly involved in creating the substantive Office Actions of record. Specifically, Applicant sought to question Examiner Jagannathan on why he still refused to accept Applicant's scientific data evidencing lower-energy hydrogen after it had been published, or was soon to be published, in what was then over 40 (now over 50) peer-reviewed journal articles, which he himself had required. Applicant, however, never got the chance to pose that question. Without explanation, Examiner Jagannathan refused to attend the Interview, just as he had refused to attend the Interview held two years earlier—only this time, he did not show up.

Applicant also requested that Examiners Wayne Langel and Stephen Kalafut attend the Interview, since they had previously allowed the five BlackLight applications that were mysteriously withdrawn from issue and their names were the only ones appearing in the record as signers of the substantive Office Actions under consideration. Examiners Langel and Kalafut did appear for the Interview, together with their immediate supervisors, SPE's Patrick Ryan and Stanley Silverman. Examiner William Wayner, who was assigned to one BlackLight application prior to his retirement from the PTO and who expressed an interest in attending the Interview, also appeared.

Also attending the Interview and leading the discussions on the PTO's behalf was Quality Assurance Specialist Douglas McGinty, who until that time had never been identified to Applicant as having played any role in the examination of his applications.

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<sup>107</sup> Although the Interview Summary does not specifically list the serial number of all BlackLight applications as being the subject of the February 11, 2003 Interview, Examiners Langel and Kalafut agreed beforehand that the Interview would be held to address the similar rejection of claims in all assigned BlackLight cases based on an alleged lack of utility and inoperability.



Attending the Interview on behalf of BlackLight Power were the inventor, Dr. Randell L. Mills, his counsel, Jeffrey S. Melcher and Jeffrey A. Simenauer, and company Director Dr. Shelby Brewer.

Also attending the Interview as an observer at Applicant's request was Ted C. Liu, Senior Legislative Assistant for Congressman David Wu, who represents the 1<sup>st</sup> District of Oregon.

During the Interview, Applicant made a sincere effort to advance the prosecution of his applications and to find common ground upon which all of these cases, once again, would be allowed to issue as patents. Applicant believed it was a worthwhile effort in light of Examiner Langel's statements on the record reaffirming his consistent view that Applicant's novel hydrogen technology is fully operable and, therefore, entitled to patent protection. The Interview was also significant in view of the following representations and agreements that resulted from the discussions between Applicant and lead-Specialist McGinty:

- (1) Applicant will identify the scientific data supporting lower energy states of hydrogen generated and furnished by independent third parties;
- (2) the Examiners whose signatures appear on the rejections of record, *i.e.*, Examiners Langel, Kalafut, and Wayner, have full authority to review that data and, based on their review, to issue patents as deemed appropriate; and
- (3) Applicant will confer with the signatory Examiners, either by telephone or in person, to review each assigned application on a claim-by-claim basis to ensure that the scientific data presented adequately supports the scope of the claims. For those claims determined to be adequately supported by the data, a patent will issue. For any claims deemed to be inadequately supported, Applicant reserves the right to continue seeking that broader claim coverage in subsequent proceedings.

Applicant appreciated the guidance Specialist McGinty provided during the Interview for securing BlackLight's patents. Based on that guidance, Applicant presented comments in two pending applications for which Responses were due detailing the substance of discussions held at the Patent Office on February 11<sup>th</sup> and

identifying the independent, third-party data per agreement (1) above, which information is reproduced below. [U.S. Serial Nos. 09/110,678 and 09/362,693]

Applicant's comments confirmed Examiner Langel's long-held view that the claims in those cases were in condition for allowance. Applicant therefore requested that Examiner Langel exercise his authority to issue a Notice to that effect per agreement (2) above so that patents could then be issued.

Following up on the Responses filed in those pending applications per agreement (3) above, Applicant arranged for an Interview with Examiner Langel to review the cases on a claim-by-claim basis to ensure that the scientific data presented adequately supported the scope of the claims in those cases. In fact, Applicant and Examiner Langel reached a tentative understanding that certain claims were adequately supported by the data and that Applicant was therefore entitled to his patents.

Unfortunately for Applicant, that understanding was short lived after Examiner Langel, "for moral and ethical reasons," agreed under the most grievous of circumstances to his removal from examining all BlackLight applications to which he was assigned. Applicant was dismayed to further learn from Examiner Langel that the PTO has adopted an "allowance is not an option" policy with respect to all pending BlackLight applications. Before discussing the prejudicial ramifications of these unfortunate incidents, however, Applicant presents the following recap of the discussions held during the February 11, 2003 Interview that lead to the above agreements.<sup>108</sup>

Just prior to the Interview, Specialist McGinty asked that Mr. Liu speak by telephone with Talis Dzenitis, a Congressional Affairs Specialist in the PTO's Legislative and International Affairs Office, to discuss his reasons for attending. Mr. Liu explained to Specialist Dzenitis that a constituent associated with BlackLight had contacted Congressman David Wu complaining of the irregular procedures the PTO has used in examining the company's pending patent applications. The procedures complained of included the PTO's withdrawal of the five applications approved by Examiners Langel

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<sup>108</sup> Much of the substance of these discussions was confirmed in e-mail correspondence between Mr. Liu and Applicant's Counsel. [See Attachment P]

and Kalafut for issuance as patents and the subsequent rejection of those and other BlackLight applications by an unknown group of PTO officials referred to by Applicant as a "Secret Committee."

Specialist Dzenitis represented to Mr. Liu that no such secret committee existed at the Patent Office. Applicant was surprised by that representation considering that a group of anonymous PTO officials were known to be handling BlackLight's applications and drafting the substantive Office Actions that the Examiners of record were instructed to sign.

Examiner Langel confirmed as much in an extended discussion he had with Mr. Liu and Applicant's counsel following the formal phase of the Interview. During that discussion, Examiner Langel repeated his prior denials of having authored the substantive Office Actions of record in the BlackLight applications to which he was assigned, even though those Actions bear his signature. Examiner Langel also repeated his previously expressed views that Applicant is entitled to patents on his novel hydrogen technology and that he wanted to issue those patents. Examiner Langel explained, however, that other PTO officials unknown to him having higher authority were responsible for drafting the substantive Office Actions he signed and for deciding whether to issue Applicant his patents.

The only person Examiner Langel could identify for Mr. Liu as "having something to do with the Office Actions" was Examiner Jagannathan, whose name does not appear on any Office Action. As noted above, Examiner Jagannathan kept his identity a secret from Applicant until counsel exposed his direct involvement in creating the Office Actions of record and forced him to attend the prior Interview that he led on February 21, 2001. [See January 19, 2001 letter to Director Esther Kepplinger (Attachment K) and February 12, 2001 Letter from Director Jacqueline M. Stone (Attachment N)] When the recent February 11, 2003 Interview started, it was Specialist McGinty, another previously unidentified PTO official, who led the discussion.

Following the telephone conversation with Specialist Dzenitis, in which he denied the existence of a secret committee, Mr. Liu joined the Interview already in progress. Applicant began the Interview with a general discussion of his novel hydrogen technology and a presentation of the experimental evidence confirming its operation

and utility. Specifically, Applicant explained to the PTO officials in attendance how independent laboratory studies, including those conducted by a leading Los Alamos researcher and by a NASA funded group, as well as other highly reliable scientific data, demonstrate the existence of lower energy states of hydrogen underlying his technology.

At no time during Applicant's presentation did the PTO officials analyze or otherwise address to any significant degree the merits of that data proving the existence of lower-energy hydrogen. Rather, these officials—with the exception of Examiner Langel—raised non-technical arguments, similar to those raised in the pending Office Actions, why lower-energy hydrogen could not exist and, thus, why they were justified in according the real-world data little or no weight.

The first such argument, raised by Examiner Wayner, was based on unrelated technologies that have been subjected to ridicule in the scientific community, such as perpetual motion, cold fusion, and 100-miles-per-gallon carburetors. Examiner Wayner compared those controversial technologies to BlackLight's novel hydrogen chemistry and then asked Applicant: "How is your invention any different?"

Applicant pointed out significant differences. Unlike the far-fetched inventions mentioned by Examiner Wayner, Applicant explained that his inventions have been actually reduced to practice, as demonstrated by the many working prototype energy cells developed over the past ten years and the novel chemical compounds produced by the process, which were made available to the PTO in the past and again during the Interview. In fact, Applicant invited the PTO officials to visit his laboratory in Cranbury, New Jersey and witness the operation of his energy cells for themselves, but like prior invitations, this one too was ignored.

Applicant further distinguished his claimed inventions based on the substantial body of experimental evidence that corroborates the existence of lower energy states of hydrogen. Again, none of the PTO officials who raised non-technical arguments questioning the operability of Applicant's novel hydrogen technology made any real attempt to analyze that corroborating evidence. Indeed, Examiner Wayner frankly admitted that his background was in mechanical engineering and, therefore, he was not qualified to conduct such an analysis.

Examiner Wayner also questioned why, if BlackLight's technology was such an important discovery, the company had not yet developed a commercial device for producing energy. Applicant explained that the high cost of developing commercial products was an impediment and that, because BlackLight was not positioned to handle commercial development, it was looking to license patents on its technology to other companies for commercialization purposes.

Concerned that Examiner Wayner might be introducing yet another new patentability standard, requiring the sale of a commercial product, counsel pressed the Examiner on whether that was his intention. Examiner Wayner plainly stated it was not and, in response to a specific question from Mr. Liu, affirmed that Applicant need not prove commercial applicability to secure a patent for his invention.<sup>109</sup>

Applicant also became alarmed when Examiner Wayner, in referring generally to BlackLight's "detractors," invoked only the name of APS lobbyist and spokesman Dr. Robert Park as someone who disputes the existence of lower energy states of hydrogen.<sup>110</sup> Applicant's counsel wanted to raise issues relating to Dr. Park's "Deep Throat" contact in the Patent Office and his reputation for conducting "hatchet jobs" on new technologies that threaten his lobbying of hundreds of millions of dollars on behalf of the APS to federally fund its pet projects. [See *supra*.] Specialist McGinty, however, cut counsel off, refusing to discuss the matter. When Specialist McGinty suggested that BlackLight has a "similar agenda," noting its recent NASA contract, Applicant corrected him, explaining that BlackLight does not receive any government funding for its

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<sup>109</sup> Despite these assurances, Applicant is proceeding under the assumption that the PTO is requiring proof of commercial applicability, especially in light of his discovery that the Committee now takes the position that "allowance is not an option" in BlackLight's cases. [See *infra*.]

<sup>110</sup> To Applicant's astonishment, in the Office Actions issued in Examiner Wayner's one assigned case, the Committee has continued to cite Dr. Park's biased statements against Applicant as a basis for rejecting claims in this case:

The opinion of Robert Park set forth in the Examiner's action of 4/14/00, paper #16. i.e. "But according to the country's leading organization of academic physicists, Mills' hydrino theory has no credibility. "There is virtually nothing that science does not know about the hydrogen atom," said Robert Park, director of the Washington [sic] office of the American Physical Society. "The ground state is defined as the (energy) state below which you cannot go ... the thought there is some state below the ground state is kind of humorous [sic]." [See 4/26/04 Office Action at p. 4 in U.S. App'n Ser. No. 09/181,180.]

research. Specialist McGinty had no response and the discussion moved onto other, less controversial subjects.

Examiner Wayner raised other issues regarding the reliability of the scientific evidence presented by Applicant. That evidence included spectroscopic data, which counsel described as being equivalent to a "chemical fingerprint." Counsel further noted that Dr. Park himself, whom Examiner Wayner identified as BlackLight's chief antagonist, has proclaimed the extraordinary reliability of spectroscopic data. [See *supra*.]

Yet when Applicant tried to present this highly reliable spectroscopic data at the Interview showing the spectral lines corresponding to lower-energy hydrogen, *i.e.*, a "hydrino" state, Examiner Wayner interrupted, commenting that "spectroscopic lines are meaningless" and "don't mean a hill of beans" to him. That comment was reminiscent of a previous one by Examiner Jagannathan characterizing Applicant's spectroscopic data as "a bunch of squiggly lines." [See *supra*.]

Counsel again became concerned that BlackLight's applications were being evaluated using rather loose patentability standards. Counsel therefore requested that the PTO officials provide some guidance regarding the evidentiary requirements they were imposing on Applicant. Specialist McGinty and Examiner Wayner at first did not respond directly to Counsel's request for guidance, but rather began questioning the accuracy of the test data Applicant submitted to confirm the existence of lower energy hydrogen.

Applicant explained that the submitted test data was generated by highly qualified Ph.D. scientists, many of whom represent independent laboratories. Applicant further noted how this data had been extensively peer-reviewed in the 40-plus (now over 50) articles published, or soon to be published, in prestigious scientific journals, including the *Journal of Applied Physics*. Applicant also provided Specialist McGinty—much to his surprise—with specific data showing the lower-energy state spectral lines that were published in the prestigious spectroscopic publication, *Journal of Molecular Structure*.

Applicant was astounded by the refusal of Specialist McGinty and Examiner Wayner to accept the reliability of the scientific data appearing in these published

journal articles, especially considering the PTO's routine acceptance of evidence submitted in printed publications to overcome utility rejections. See, e.g., MPEP § 2107.01 (VI) pp. 2100-33 ("An applicant can [submit evidence in response to a utility rejection] using any combination of the following: amendments to the claims, arguments or reasoning, or new evidence submitted in an affidavit or declaration under 37 CFR 1.132, or in a **printed publication**." (emphasis added)).

Counsel also reminded the PTO officials of the standard imposed by lead-Examiner Jagannathan during the previous Interview held February 21, 2001 that conditioned his consideration of evidence of lower-energy hydrogen on its publication in peer-reviewed journal articles based on the reliability of the peer-review process. Counsel then noted once again that, despite Examiner Jagannathan's failure to provide legal authority for imposing this unreasonable standard, Applicant had not only met it, but had exceeded it with over 40 (now over 50) journal articles. Having done so, counsel expressed extreme frustration with the PTO's continued refusal to seriously analyze the published scientific data based on manufactured excuses, such as this newly concocted one concerning the accuracy of Applicant's data.

Specialist McGinty raised yet another weak excuse for ignoring the published data by asking what assurances Applicant could provide that the journal articles had been actually peer reviewed! Mystified by that question, Applicant could only state what is a simple known fact: to get scientific data published in a journal article, it must first go through a rigorous peer-review process. Indeed, many of Applicant's articles went through numerous drafts and required further experimentation as directed by the Ph.D. scientists who peer reviewed those articles.

At that point in the Interview, Specialist McGinty admitted that, like Examiner Wayner, he was not qualified to analyze the published data. Applicant was surprised by that admission, since the Interview was being led by Specialist McGinty and had been arranged for the express purpose of presenting the experimental evidence of record.

Examiner McGinty's admission merely fueled Applicant's prior concerns that his published scientific data was not being properly considered, prompting counsel to ask who was responsible for analyzing that data. Specialist McGinty replied by stating that Examiners Langel and Kalafut, the Examiners of record, had that responsibility. That

too came as a surprise since Examiners Langel and Kalafut were the ones who had originally reviewed Applicant's experimental evidence in allowing the five BlackLight applications that were subsequently withdrawn from issue. Applicant, however, was relieved to learn that these two Examiners, who had over 50 years of experience between them and who were obviously qualified to analyze the published data, were being reassigned that task.

Counsel then addressed the vexing problem of constantly changing patentability standards that had been plaguing the examination process. Counsel specifically mentioned, for example, the prior Office Actions that claimed Applicant's lower-energy hydrogen technology violated known laws of physics and chemistry without specifically identifying even one such law, and then required Applicant to prove otherwise.

Counsel also cited a recent Office Action dismissing Applicant's scientific data out of hand for failing to prove the invalidity of quantum theory:

The request for reconsideration has been entered and considered but does not overcome the rejection . . . because there is no evidence presented which would prove applicant's contention that the theory of quantum mechanics is invalid."  
[October 7, 2002 Advisory Action entered in U.S. Serial No. 09/110,717]

When Specialist McGinty accused Applicant of putting a "spin" on the Examiner's rejection, counsel noted that he had been reading the above quotation directly from the Office Action.

Counsel also mentioned other recent Office Actions filed in BlackLight cases that dismissed Applicant's recent submission of peer-reviewed journal articles, in accordance with the standards imposed by Examiner Jagannathan, as being merely "cumulative" when it clearly was not and even the originally submitted evidence had not been properly analyzed.

Expressing frustration over the PTO's failure to provide any consistent patentability standards to guide Applicant, counsel once again requested that Specialist McGinty provide such guidance. Specialist McGinty again raised concern over the



integrity of the experimental evidence, but indicated that he would be more receptive to that evidence if it was validated by independent third parties.<sup>111</sup>

Applicant explained to Specialist McGinty that much of the evidence submitted over the previous four years was, in fact, generated by independent third parties. Applicant then began citing examples of the extensive independent third-party evidence disclosed in publications previously cited to the PTO, as well as more recently generated evidence that was subsequently submitted.<sup>112</sup> Specialist McGinty did not respond, whereupon counsel noted that the PTO's unfounded concern that the record evidence lacked third-party validation merely demonstrated its failure to thoroughly analyze that evidence.

Further demonstrating a lack of familiarity with the record evidence, Specialist McGinty criticized Applicant's experimental evidence as a whole by referring numerous times to only high-power plasma data. Applicant repeatedly pointed out that the plasma data was but a small fraction of the submitted evidence and that it was presented primarily to provide additional support for his plasma-related applications.

Applicant noted that the vast body of other scientific data he submitted relates to a broad range of analytical studies demonstrating the existence of lower energy states of hydrogen. For example, regarding those applications relating to novel chemical compounds, Applicant pointed Specialist McGinty to the extensive spectroscopic data

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<sup>111</sup> Just as Specialist McGinty sought assurances at the February 11 Interview that persons involved in generating and furnishing the scientific data submitted by Applicant are independent and unbiased, Applicant deserves similar assurances that those involved in rejecting BlackLight's applications are also independent and unbiased. Despite Applicant's repeated requests for such assurances, none have been given. The genuine conflicts of interest uncovered by Applicant involving Examiner Souw and his clearly biased views against BlackLight adopted by the Committee merely underscore the importance of this highly relevant information.

<sup>112</sup> See R. L. Mills, B. Dhandapani, M. Nansteel, J. He, A. Voigt, "Identification of Compounds Containing Novel Hydride Ions by Nuclear Magnetic Resonance Spectroscopy", *Int. J. Hydrogen Energy*, Vol. 26, No. 9, (2001), pp. 965-979.

R. L. Mills, P. Ray, B. Dhandapani, M. Nansteel, X. Chen, J. He, "New Power Source from Fractional Quantum Energy Levels of Atomic Hydrogen that Surpasses Internal Combustion", *J. Mol. Struct.*, Vol. 643, No. 1-3, (2002), pp. 43-54.

J. Phillips, R. L. Mills, X. Chen, "Water Bath Calorimetric Study of Excess Heat in 'Resonance Transfer' Plasmas", *Journal of Applied Physics*, submitted.

A. J. Marchese, P. M. Jansson, J. L. Schmalzel, "The BlackLight Rocket Engine", Phase I Final Report, NASA Institute for Advanced Concepts Phase I, May 1-November 30, 2002, [http://www.niac.usra.edu/files/studies/final\\_report/pdf/752Marchese.pdf](http://www.niac.usra.edu/files/studies/final_report/pdf/752Marchese.pdf).

supporting the identification of those compounds. Specialist McGinty, however, apparently did not understand the significance of that data, stating that the NMR data confirming lower-energy hydrogen could have been due to nitrogen. Applicant had to explain that, as a matter of basic scientific knowledge, NMR data only shows protons and that no other element but hydrogen is in the data range. Applicant also explained that the NMR data confirms the presence of an internal energy source.

Knowing that highly qualified Examiners Langel and Kalafut were once again responsible for analyzing the published data was reassuring. There still remained, however, one nagging issue, namely, who had the ultimate authority to issue Applicant his patents. Counsel expressed concern that the pending applications were being examined in secret and that, without knowing who had that authority, Applicant was being unfairly denied an opportunity to present his case to the actual decision-maker.

Specialist McGinty then stated in no uncertain terms that Examiners Langel, Kalafut, and Wayner, the signers of the Office Actions under consideration, had "full authority" to examine the pending applications and to issue the patents.

Upon hearing that statement, counsel immediately turned to Examiner Langel and asked him point blank whether, after having studied the experimental evidence of record, he still believed that BlackLight's patent applications were allowable. The Examiner replied in no uncertain terms, "Yes, they're still allowable."

Counsel then asked Examiner Langel whether he was prepared to immediately allow the claims and issue Applicant his patents in those applications assigned to him, as is customary during an Interview, to which the Examiner replied, "Fine with me."

Specialist McGinty, however, expressed uneasiness over Examiner Langel's agreement to allow claims at the Interview. Specifically, he stated his concern that even if Applicant's claimed technology were found to be operable, there were still issues of novelty and nonobviousness to be addressed before a patent could be issued.

Counsel was surprised by that statement given the PTO's arguments over the prior three years that Applicant's inventions were inoperable based on an incorrect assumption that lower-energy hydrogen cannot possibly exist. Counsel pointed out the obvious contradiction in arguing that the Examiners may still need to conduct a prior art search for possible disclosure of Applicant's lower-energy hydrogen technology.

Counsel further noted the PTO's own examination guidelines requiring Examiners to evaluate the operability and utility of a claimed invention together with its novelty and nonobviousness following a complete prior art search. See MPEP § 706.<sup>113</sup> Counsel again turned to Examiner Langel to confirm whether that was his understanding. The Examiner replied that it was and indicated that, in fact, the first thing he did was to conduct a thorough prior art search because he thought that might be the easiest way to dispose of the applications assigned to him. Examiner Langel explained, however, that he was unable to reject the applications on prior art grounds, which was why he originally allowed them.

Counsel acknowledged Specialist McGinty's hesitance to issue Applicant patents covering his claims at the Interview and assured him that Applicant wanted to work with him to remove any lingering concerns. Counsel then specifically asked Specialist McGinty to articulate how they might proceed in trying to accomplish that mutually beneficial goal. In response, Specialist McGinty indicated that, in the next Response to any pending or subsequent Office Actions, Applicant should focus on identifying the scientific data generated by independent third-party testing, as opposed to test data generated solely by Applicant. Counsel agreed to do that.

Specialist McGinty further expressed concern over whether that scientific data, even if assumed to be reliable, was commensurate with the scope of the claims of the various applications to adequately support patentability. Counsel stated that Applicant's data did adequately support the claimed subject matter. Counsel, however, recommended reviewing the claims of each application one by one with the assigned Examiners to see if at least some agreement could be reached as to those claims that are adequately supported and for which patents can be issued. As for any remaining

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<sup>113</sup> MPEP § 706 provides in pertinent part:

After the application has been read and the claimed invention understood, a prior art search for the claimed invention is made. With the results of the prior art search, including any references provided by the applicant, the patent application should be reviewed and analyzed in conjunction with the state of the prior art to determine whether the claims define a useful, novel, nonobvious, and enabled invention that has been clearly described in the specification. The goal of examination is to clearly articulate any rejection early in the prosecution process so that the applicant has the opportunity to provide evidence of patentability and otherwise reply completely at the earliest opportunity.

claims that the Examiners believe are not adequately supported by the scientific data, Applicant would be free to seek such broader claim coverage through continued prosecution.

Specialist McGinty agreed that this was a reasonable way to proceed and granted a request by counsel, Mr. Simenauer, that this agreement be memorialized in writing in an attachment to the Interview Summary Form. Mr. Simenauer offered to draft this agreement, as is common practice, and Specialist McGinty enthusiastically accepted the offer. Mr. Simenauer then drafted the following Attachment as Specialist McGinty looked on:

**ATTACHMENT TO INTERVIEW SUMMARY FORM**

Applicant requested that the following points discussed at the Interview held on February 11, 2003 be included as an Attachment to the Interview Summary Form.

Applicant's counsel and the Examiners in attendance at the Interview agreed to meet again at a future date, either in person or by telephone, to continue discussions regarding the patentability of Applicant's pending patent applications. Specifically, the Examiners expressed concern that Applicant's experimental evidence be commensurate with the scope of the claims. To address that concern, Applicant's counsel agreed with the Examiners to go through the patent applications claim-by-claim with the Examiners and demonstrate how the scientific data supports those claims.

For those claims that are supported by the data, the PTO agrees to issue those claims. For those claims that the PTO determines are not supported by the data, Applicant will continue to seek that broader claim coverage in subsequent proceedings. [Attachment F]

After completing the two-page handwritten Attachment, Mr. Simenauer read it out loud in the presence of Specialist McGinty and Examiner Langel so that they could confirm its accuracy and make any necessary changes. When asked by counsel whether they were satisfied with the wording of the Attachment, Specialist McGinty stated that he was, as did Examiner Langel, who then signed each of the two pages. There was absolutely no confusion as to the agreement to issue patents for those claims found to be supported by the scientific data.

Incredibly, in a transparent attempt to rewrite history, some unknown PTO official apparently instructed Examiner Langel to sign a subsequent communication mailed over two weeks later, on February 26, 2003, that included an attached "Supplement to Interview Summary" (Attachment F), which provides in pertinent part:

The following is a supplement to the summary concerning the February 11, 2003 interview re 09/501,622, etc. . . . A two-page Interview Summary was provided by Examiner Langel. A two page "Attachment to Interview Summary Form" also was provided by Mr. Simenauer. While the Attachment may represent the applicant's understanding of the interview, two points must be clarified.

First the second page of the applicant's attachment states in part: "for those claims that are supported by the data, the PTO agrees to issue those claims." The PTO made no such agreement. Instead, the PTO representatives indicated that the rejections under both 35 USC 101 and 112, 1<sup>st</sup> para., are outstanding and that evidence as to verification by credible, established, independent third parties would carry more persuasive weight.

Second, QAS Douglas McGinty was not listed in the Examiner's Interview Summary. He was present during the interview with the aforementioned attendees.

[signed] Wayne Langel  
Primary Examiner  
Art unit 1754

If PTO officials wanted to retract one of the key agreements reached at the Interview, they should have expressly said so, identifying who made the decision and giving reasons for the retraction. Since this was not done, Applicant has no choice but to rely on the accuracy of the contemporaneous written record.

Moreover, in view of other agreements reached at the Interview, the suggestion that there was no agreement to issue patents under the stated conditions is absurd—though hardly surprising given the sordid prosecution history of BlackLight's patent applications. Specialist McGinty plainly stated on the record that the Examiners who signed the outstanding rejections have full authority to review the data and to issue Applicant his patents. Also of record is Examiner Langel's unequivocal statement that, based on his review, he was prepared to issue those patents. To then force this same Examiner to sign a statement two weeks after the fact denying that "for those claims

that are supported by the data, the PTO agrees to issue those claims" is, frankly, embarrassing.

Other ineffective arguments, such as those made by Examiner Kalafut that "the present Examiner did not commit to any agreements during the interview," are also disappointing and, hopefully, will not be repeated. [See Advisory Action dated April 2, 2003 filed in U.S. App'n Ser. No. 08/467,911.] Applicant acknowledges that, to the best of his recollection, Examiner Kalafut, although present at the February 11 Interview, did not speak a word. As previously indicated, it was Specialist McGinty who led the Interview on behalf of the PTO and it was he who ultimately agreed to the terms under which examination of BlackLight's patent applications would proceed, which terms were expressly reduced to writing. For Examiner Kalafut, or any other Examiner assigned to one of BlackLight's applications, to now attempt to distance themselves from that agreement based on the weak assertion that they did not personally commit to it during the Interview merely illustrates yet another example of the PTO's arbitrary and capricious approach to examining these applications.

**Applicant's Identification of Scientific Data Supporting Lower energy States of Hydrogen Generated and Furnished By Independent Third-Parties**

In light of the controversial prosecution history of this and other pending BlackLight cases, Applicant appreciated what seemed to be Specialist McGinty's willingness to set reasonable standards and guidelines by which Applicant's patents could finally be issued. Applicant acknowledged and documented Specialist McGinty's concern over the reliability of the record evidence, which led to his requirement that Applicant identify independent third-party verification of the scientific data as noted in the PTO's Supplement to Interview Summary. With those standards and guidelines in mind, Applicant presented in two pending applications a summary of the scientific data supporting lower energy states of hydrogen generated and furnished by independent third parties, which data is reproduced below along with additional, newly submitted data.<sup>114</sup>

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<sup>114</sup> See U.S. App'n Ser. Nos. 09/110,678 and 09/362,693.

**Experimental Evidence Generated by Independent Third Parties**

Applicant is unaware of any statutes, rules, or case law requiring that experimental evidence submitted by an Applicant in response to a rejection by the PTO be generated by independent third parties. Despite the higher standard imposed by Specialist McGinty requiring such third-party validation of the evidence, Applicant still has met and far exceeded this standard as shown below.

Applicant provides the following alphabetical list of independent third-party laboratories and universities that conducted the experiments and generated the scientific data relied upon and discussed in the analytical studies that follow this list:

Advanced Research - Pirelli Labs, Milan, Italy

Aero Propulsion and Power Directorate, Wright Laboratory, Air Force Material Command (ASC), Wright-Patterson Air Force Base

Atomic Energy Canada Limited, Chalk River Laboratories

Brookhaven National Laboratory

Charles Evans & Associates, Sunnyvale, CA

Charles Evans East, East Windsor, NJ

Environmental Catalysis and Materials Laboratory of Virginia Polytechnic Institute

Franklin and Marshall College

Galbraith Laboratories, Inc., Knoxville, TN

Grace Davison, Columbia, MD

IC Laboratories, Amawalk, NY

Idaho National Engineering Laboratory

Institut für Niedertemperatur-Plasmaphysik e.V. (INP Greifswald, Germany)

Jobin Yvon Inc., Edison, NJ

Laboratory for Electrochemistry of Renewed Electrode-Solution Interface (LEPGER)

Liebert Corporation, Division of Emerson Corporation

Los Alamos National Laboratory

Material Testing Laboratory, Pennington, NJ

MIT Lincoln Laboratories

Moscow Power Engineering Institute

NASA Lewis

National Research Council of Canada

PacifiCorp

Pennsylvania State University Chemical Engineering Department

Perkin-Elmer Biosystems, Framingham, MA

Pirelli Labs, Milan, Italy

Ricerca, Inc., Painesville, Ohio

Rider University, Lawrenceville NJ

Rowan University Professors A. J. Marchese, P. M. Jansson, J. L. Schmalzel

Ruhr University, Bochum, Germany

Shrader Analytical & Consulting Laboratories

Spectral Data Services, Inc., Champaign, IL

S. S. W., University of Western Ontario, Canada

Surface Science Laboratories, Mountain View, CA

Thermacore, Inc., Lancaster, PA

University of Delaware, Wilmington, DE

University of Massachusetts Amherst, Amherst, MA



University of New Mexico

Westinghouse Electric Corporation

Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University,  
Bethlehem, PA

The following 47 abstracts briefly describe the analytical studies of the scientific data generated by these independent third parties (highlighted in underline).

### Independent Test Results

51. **J. Phillips, C-K Chen, R. Mills, "Evidence of catalytic Production of Hot Hydrogen in RF Generated Hydrogen/Argon Plasmas", IEEE Transactions on Plasma Science, submitted.**

J. Phillips, Distinguished National Laboratory Professor at Los Alamos National Laboratory and University of New Mexico, performed verification studies of line broadening in catalysis plasmas. This is the third in a series of papers by our team on apparently anomalous Balmer series line broadening in hydrogen containing RF generated, low pressure (< 600 mTorr) plasmas. In this paper the selective broadening of the atomic hydrogen lines in pure H<sub>2</sub> and Ar/H<sub>2</sub> mixtures in a large "GEC" cell (36 cm length X 14 cm ID) was mapped as a function of position, H<sub>2</sub>/Ar ratio, time, power, and pressure. Several observations regarding the selective line broadening were particularly notable as they are unanticipated on the basis of earlier models. First, the anomalous broadening of the Balmer lines was found to exist throughout the plasma, and not just in the region between the electrodes. Second, the broadening was consistently a complex function of the operating parameters particularly gas composition (highest in pure H<sub>2</sub>) position, power and pressure. Clearly not anticipated by earlier models were the findings that under some conditions the highest concentration of "hot" (>10 eV) hydrogen was found at the entry end, and not in the high field region between the electrodes and that in other conditions, the hottest H was at the (exit) pump (also grounded electrode) end. Third, excitation and electron temperatures were less than one eV in all regions of the plasma not directly adjacent (>1mm) to the

electrodes, providing additional evidence that the energy for broadening, contrary to standard models, is not obtained from the field. Fourth, in contrast to our earlier studies of hydrogen/helium and water plasmas, we found that in some conditions 98% of the atomic hydrogen was in the "hot" state throughout the GEC cell. Virtually every operating parameter studied impacted the character of the hot H atom population, and clearly second and third order effects exist, indicating a need for experimental design. Some non-field mechanisms for generating hot hydrogen atoms, specifically those suggested by Mills' CQM model, are outlined.

**50. J. Phillips, C. K. Chen, R. Mills, "Evidence of the Production of Hot Hydrogen Atoms in RF Plasmas by Catalytic Reactions Between Hydrogen and Oxygen Species", *Spectrochimica Acta Part B: Atomic Spectroscopy*, submitted.**

J. Phillips, Distinguished National Laboratory Professor at Los Alamos National Laboratory and University of New Mexico, performed verification studies of line broadening in catalysis plasmas. Selective H-atom line broadening was found to be present throughout the volume (13.5 cm ID x 38 cm length) of RF generated  $H_2O$  plasmas in a GEC cell. Notably, at low pressures (ca. <0.08 Torr), a significant fraction (ca. 20%) of the atomic hydrogen was 'hot' with energies greater than 40 eV with a pressure dependence, but only a weak power dependence. The degree of broadening was virtually independent of the position studied within the GEC cell, similar to the recent finding for  $He/H_2$  plasmas in the same GEC cell. In contrast to the atomic hydrogen lines, no broadening was observed in oxygen species lines at low pressures. Also, in 'control'  $Xe/H_2$  plasmas run in the same cell at similar pressures and adsorbed power, no significant broadening of atomic hydrogen,  $Xe$ , or any other lines was observed. Stark broadening or acceleration of charged species due to high electric fields can not explain the results since i) the electron density was insufficient by orders of magnitude, ii) the RF field was essentially confined to the cathode fall region in contrast to the broadening that was independent of position, and iii) only the atomic hydrogen lines were broadened. Rather, all of the data is consistent with a model that

claims specific, predicted, species can act catalytically through a resonant energy transfer mechanism to create 'hot' hydrogen atoms in plasmas.

**49. R. L. Mills, Y. Lu, B. Dhandapani, "Spectral Identification of  $H_2(1/2)$ ", submitted.**

Lower-energy molecular hydrogen lines were independently recorded and interpreted by Stephan Fuelling of the University of Nevada, Reno and the Nevada Terawatt Facility and provided to BlackLight. Novel emission lines with energies of  $q \cdot 13.6 \text{ eV}$  where  $q = 1, 2, 3, 4, 6, 7, 8, 9, \text{ or } 11$  were previously observed by extreme ultraviolet (EUV) spectroscopy recorded on microwave discharges of helium with 2% hydrogen [R. L. Mills, P. Ray, J. Phys. D, Applied Physics, Vol. 36, (2003), pp. 1535-1542]. These lines matched  $H(1/p)$ , fractional Rydberg states of atomic hydrogen wherein  $n = \frac{1}{2}, \frac{1}{3}, \frac{1}{4}, \dots, \frac{1}{p}$ ; ( $p \leq 137$  is an integer) replaces the well known parameter  $n = \text{integer}$  in the Rydberg equation for hydrogen excited states. Evidence supports that these states are formed by a resonant nonradiative energy transfer to  $He^+$  acting as a catalyst; whereas, krypton, xenon, and their ions serve as controls. Two  $H(1/2)$  may react to form  $H_2(1/2)$  with emission of the bond energy from a resonant state within its transition state with vibration-rotational energies that are the same as those of  $H_2$ . A series of vibration-rotational bands in the 60-67 nm region, a high-energy region for which vibration-rotational spectra are ordinarily unknown, was observed from low-pressure helium-hydrogen (99/1%) microwave plasmas that matched the predicted energy spacing of the vibrational energy of  $H_2$  about the bond energy of  $H_2(1/2)$  corresponding to the reaction  $2H(1/2) \rightarrow H_2(1/2)$ .

**48. J. Phillips, C. K. Chen, "Evidence of Energetic Reaction Between Helium and Hydrogen Species in RF Generated Plasmas", Philosophy Magazine, submitted.**

A study of the line shapes of hydrogen Balmer series lines in RF generated low pressure  $H_2/He$  plasmas performed at the University of New Mexico, Department of

Chemical and Nuclear Engineering produced results suggesting a catalytic process between helium and hydrogen species results in the generation of 'hot' (ca. 28 eV) atomic hydrogen. Even far from the electrodes (ca. 15 cm) both 'cold' (<2.5 eV) and 'hot' atomic hydrogen were found in H<sub>2</sub>/He plasmas. Line shapes, relative line areas of cold and hot atomic hydrogen (hot/cold>2.5), were very similar for areas between the electrodes and far from the electrodes for these plasmas. In contrast, in H<sub>2</sub>/Xe only 'warm' (<5 eV) hydrogen (warm/cold<1.0) was found between the electrodes, and only cold hydrogen away from the electrodes. Earlier postulates that preferential hydrogen line broadening in plasmas results from the acceleration of ionic hydrogen in the vicinity of electrodes, and the special charge exchange characteristics of Ar/H<sub>2</sub><sup>+</sup> are clearly belied by the present results that show atomic hydrogen line shape are similar for H<sub>2</sub>/He plasmas throughout the relatively large cylindrical (14 cm ID x 36 cm length) cavity.

47. **R. L. Mills, P. Ray, M. Nansteel, J. He, X. Chen, A. Voigt, B. Dhandapani, Luca Gamberale, "Energetic Catalyst-Hydrogen Plasma Reaction as a Potential New Energy Source", J. Phys. B: At. Mol. Opt. Phys., submitted.**

Luca Gamberale of the Advanced Research - Pirelli Labs, Milan, Italy performed verification studies as a visiting researcher at BlackLight Power, Cranbury, NJ. The prior reported results of BlackLight Power, Inc. of a chemically generated hydrogen plasma, extraordinarily broadened atomic hydrogen lines, lower-energy hydrogen molecular-ion lines, the isolation and characterization of lower-energy molecular hydrogen gas, and excess power measured by water bath calorimetry were replicated. Specifically, plasmas of certain catalysts such as  $Sr^+$ ,  $Ar^+$ , and  $He^+$  mixed with hydrogen were studied for evidence of a novel energetic reaction. A hydrogen plasma was observed to form at low temperatures (e.g.  $\approx 10^3 K$ ) and an extraordinary low field strength of about 1-2 V/cm when argon and strontium were present with atomic hydrogen. RF and microwave plasmas were used to generate  $He^+$  and  $Ar^+$  catalysts. Extraordinarily fast H (40-50 eV) was observed by Balmer  $\alpha$  line broadening only from plasmas having a catalyst with H. Novel emission lines with energies of  $q \cdot 13.6 eV$  where  $q = 1, 2, 3, 4, 6, 7, 8, 9$ , or 11 were previously observed by extreme ultraviolet (EUV)

spectroscopy recorded on microwave discharges of helium with 2% hydrogen [R. L. Mills, P. Ray, J. Phys. D, Applied Physics, Vol. 36, (2003), pp. 1535-1542]. These lines matched  $H(1/p)$ , fractional Rydberg states of atomic hydrogen wherein

$$n = \frac{1}{2}, \frac{1}{3}, \frac{1}{4}, \dots, \frac{1}{p}; \quad (p \leq 137 \text{ is an integer})$$

replaces the well known parameter  $n = \text{integer}$  in

the Rydberg equation for hydrogen excited states.  $H(1/p)$  may react with a proton and two  $H(1/p)$  may react to form  $H_2(1/p)^+$  and  $H_2(1/p)$ , respectively, that have vibrational and rotational energies that are  $p^2$  times those of the species comprising uncatalyzed atomic hydrogen. A series of over twenty peaks in the 10-65 nm region emitted from low-pressure helium-hydrogen (90/10%) and argon-hydrogen (90/10%) microwave plasmas matched the energy spacing of  $2^2$  times the transition-state vibrational energy of  $H_2^+$  with the series ending on the bond energy of  $H_2(1/4)^+$ .  $H_2(1/p)$  gas was isolated by liquefaction using an high-vacuum ( $10^{-6}$  Torr) capable, liquid nitrogen cryotrap and was characterized by gas chromatography (GC), mass spectroscopy (MS), visible and EUV optical emission spectroscopy (OES), and  $^1H$  NMR of the condensable gas dissolved in  $CDCl_3$ . Novel peaks were observed by cryogenic gas chromatography performed on the condensable gas which was highly pure hydrogen by MS and had a higher ionization energy than  $H_2$ . The observation that the EUV emission spectrum changed with deuterium substitution in a region where no hydrogen emission has ever been observed further supported the existence of lower-energy molecular hydrogen. Contaminants and exotic helium-hydrogen species were eliminated as the source of the reaction and condensed gas plasma emission spectra. Upfield shifted NMR peaks were observed at 3.47 ppm and 2.18 ppm compared to that of  $H_2$  at 4.63 ppm that matched  $H_2(1/2)$  and  $H_2(1/4)$ , respectively. Excess power was absolutely measured from the helium-hydrogen plasma. For an input of 44.3 W, the total plasma power of the helium-hydrogen plasma measured by water bath calorimetry was 62.9 W corresponding to 18.6 W of excess power in  $3 \text{ cm}^3$ . The excess power density and energy balance were high,  $6.2 \text{ W/cm}^3$  and  $-5 \times 10^4 \text{ kJ/mole } H_2$  ( $240 \text{ eV/H atom}$ ), respectively.

46. R. L. Mills, Y. Lu, J. He, M. Nansteel, P. Ray, X. Chen, A. Voigt, B. Dhandapani, "Spectral Identification of New States of Hydrogen", J. Mol. Struct., submitted.

Novel emission lines with energies of  $q \cdot 13.6 \text{ eV}$  where  $q = 1, 2, 3, 4, 6, 7, 8, 9, 11$  were previously observed by extreme ultraviolet (EUV) spectroscopy recorded on microwave discharges of helium with 2% hydrogen [R. L. Mills, P. Ray, J. Phys. D, Applied Physics, Vol. 36, (2003), pp. 1535-1542]. These lines matched  $H(1/p)$ , fractional Rydberg states of atomic hydrogen wherein  $n = \frac{1}{2}, \frac{1}{3}, \frac{1}{4}, \dots, \frac{1}{p}$ ; ( $p \leq 137$  is an integer) replaces the well known parameter  $n = \text{integer}$  in the Rydberg equation for hydrogen excited states. Evidence supports that these states are formed by a resonant nonradiative energy transfer to  $He^+$  acting as a catalyst.  $Ar^+$  also serves as a catalyst to form  $H(1/p)$ ; whereas, krypton, xenon, and their ions serve as controls.  $H(1/p)$  may react with a proton and two  $H(1/p)$  may react to form  $H_2(1/p)^+$  and  $H_2(1/p)$ , respectively, that have vibrational and rotational energies that are  $p^2$  times those of the species comprising uncatalyzed atomic hydrogen. A series of over twenty peaks in the 10-65 nm region emitted from low-pressure helium-hydrogen (90/10%) and argon-hydrogen (90/10%) microwave plasmas matched the energy spacing of  $2^2$  times the transition-state vibrational energy of  $H_2^+$  with the series ending on the bond energy of  $H_2(1/4)^+$ . Rotational lines were observed in the 145-300 nm region from atmospheric pressure electron-beam excited argon-hydrogen plasmas. The unprecedented energy spacing of  $4^2$  times that of hydrogen established the internuclear distance as  $1/4$  that of  $H_2$  and identified  $H_2(1/4)$ . The results were independently recorded at Rutgers University.  $H_2(1/p)$  gas was isolated by liquefaction at liquid nitrogen temperature and by decomposition of compounds found to contain the corresponding hydride ions  $H^-(1/p)$ . The  $H_2(1/p)$  gas was dissolved in  $CDCl_3$  and characterized by  $^1H$  NMR at Rider University, Lawrenceville NJ. Considering solvent effects, singlet peaks upfield of  $H_2$  were observed with a predicted integer spacing of 0.64 ppm at 3.47, 3.02, 2.18, 1.25, 0.85, and 0.22 ppm which matched the consecutive series  $H_2(1/2)$ ,  $H_2(1/3)$ ,  $H_2(1/4)$ ,  $H_2(1/5)$ ,  $H_2(1/6)$ , and  $H_2(1/7)$ , respectively. Excess power was absolutely measured

from the helium-hydrogen plasma. For an input of 41.9 W, the total plasma power of the helium-hydrogen plasma measured by water bath calorimetry was 62.1 W corresponding to 20.2 W of excess power in  $3 \text{ cm}^3$  plasma volume. The excess power density and energy balance were high,  $6.7 \text{ W/cm}^3$  and  $-5.4 \times 10^4 \text{ kJ/mole } H_2$  ( $280 \text{ eV/H atom}$ ), respectively. In addition to power applications, battery and propellant reactions are proposed that may be transformational, and observed excited vibration-rotational levels of  $H_2(1/4)$  could be the basis of a UV laser that could significantly advance photolithography.

**45. Dr. K.D. Keefer, Report on BlackLight Power Technology: Its Apparent Scientific Basis, State of Development and Stability for Commercialization by Liebert Corporation, (2001), and, Report on BlackLight Power Technology: Its Apparent Scientific Basis, State of Development and Stability for Commercialization, (2002).**

To separate reports disclosing the results of NMR, ToF-SIMS, XPS identification of novel hydrino hydride compounds and analysis of chemically-produced plasma by an expert hired by the Liebert Corporation, a division of the well-known and highly-respected Emerson Corporation. According to the expert's own words, he "observed demonstrations of the BlackLight Power (BLP) process and ...reached the inescapable conclusion that it is based on extraordinary chemical reactions that seem to release extraordinary amounts of energy.... It is [his] professional opinion that the BLP process represents a chemical conversion of atomic hydrogen unlike any previously reported [in] the archival scientific literature." Although the expert states that he was skeptical of Applicant's theory, he admitted that the chemical and plasma data did support Applicant's fractional quantum states and that he could offer no other explanation of the data using conventional quantum theory.

**44. A. J. Marchese, P. M. Jansson, J. L. Schmalzel, "The BlackLight Rocket Engine", Phase I Final Report, NASA Institute for Advanced Concepts Phase I,**

**May 1-November 30, 2002,**

**[http://www.niac.usra.edu/files/studies/final\\_report/pdf/752Marchese.pdf](http://www.niac.usra.edu/files/studies/final_report/pdf/752Marchese.pdf).**

Rowan University Professors A. J. Marchese, P. M. Jansson, J. L. Schmalzel performed verification studies as visiting researchers at BlackLight Power, Cranbury, NJ. The prior reported results of BlackLight Power, Inc. of extraordinarily broadened atomic hydrogen lines, population inversion, lower-energy hydrogen lines, and excess power measured by water bath calorimetry were replicated. The application of the energetic hydrogen to propulsion was studied.

Specifically, the data supporting hydrinos was replicated. See

i.) BlackLight Process Theory (pp. 10-12) which gives the theoretical energy levels for hydrinos and the catalytic reaction to form hydrinos,

ii.) Unique Hydrogen Line Broadening in Low Pressure Microwave Water Plasmas (pp. 25-27, particularly Fig. 21) which shows that in the same microwave cavity driven at the same power, the temperature of the hydrogen atoms in the microwave plasma where the hydrino reaction was active was 50 times that of the control based on the spectroscopic line widths,

iii.) Inversion of the Line Intensities in Hydrogen Balmer Series (pp. 27-28, particularly Fig. 22) which shows for the first time in 40 years of intensive worldwide research that atomic hydrogen population inversion was achieved in a steady state plasma and supports the high power released from the reaction of hydrogen to form hydrinos,

iv.) Novel Vacuum Ultraviolet (VUV) Vibration Spectra of Hydrogen Mixture Plasmas (pp. 28-29, particularly Fig. 23) which shows a novel vibrational series of lines in a helium-hydrogen plasmas at energies higher than any known vibrational series and it identically matches the theoretical prediction of 2 squared times the corresponding vibration of the ordinary hydrogen species, and

v.) Water Bath Calorimetry Experiments Showing Increased Heat Generation (pp. 29-30, particularly Fig. 25) that shows that with exactly the same system and same input power, the heating of the water reservoir absolutely measured to 1% accuracy was equivalent to 55 to 62 W with the catalyst-hydrogen mixture compared to 40 W in the control without the possibility of the reaction to form hydrinos.



43. **J. Phillips, R. L. Mills, X. Chen, "Water Bath Calorimetric Study of Excess Heat in 'Resonance Transfer' Plasmas", Journal of Applied Physics, Vol. 96, No. 6, pp. 3095-3102.**

J. Phillips, Distinguished National Laboratory Professor at Los Alamos National Laboratory and University of New Mexico, performed verification studies as a visiting researcher at BlackLight Power, Cranbury, NJ. Water bath calorimetry was used to demonstrate one more peculiar phenomenon associated with a certain class of mixed gas plasmas termed resonant transfer, or rt-plasmas. Specifically,  $He/H_2(10\%)$  (500 mTorr),  $Ar/H_2(10\%)$  (500 mTorr), and  $H_2O(g)$  (500 mTorr and 200 mTorr) plasmas generated with an Evenson microwave cavity consistently yielded on the order of 50% more heat than non rt-plasma (controls) such as  $He$ ,  $Kr$ ,  $Kr/H_2(10\%)$ , under identical conditions of gas flow, pressure, and microwave operating conditions. The excess power density of rt-plasmas was of the order  $10\text{ W}\cdot\text{cm}^{-3}$ . In earlier studies with these same rt-plasmas it was demonstrated that other unusual features were present including dramatic broadening of the hydrogen Balmer series lines, unique vacuum ultraviolet (VUV) lines, and in the case of water plasmas, population inversion of the hydrogen excited states. Both the current results and the earlier results are completely consistent with the existence of a hitherto unknown exothermic chemical reaction, such as that predicted by Mills, occurring in rt-plasmas.

42. **R. L. Mills, P. C. Ray, R. M. Mayo, M. Nansteel, B. Dhandapani, J. Phillips, "Spectroscopic Study of Unique Line Broadening and Inversion in Low Pressure Microwave Generated Water Plasmas", J. Plasma Phys., submitted.**

J. Phillips, Distinguished National Laboratory Professor at Los Alamos National Laboratory and University of New Mexico, performed verification studies as a visiting researcher at BlackLight Power, Cranbury, NJ. It was demonstrated that low pressure ( $\sim 0.2$  Torr) water vapor plasmas generated in a 10 mm ID quartz tube with an Evenson microwave cavity show at least two features which are not explained by conventional plasma models. First, significant ( $> 2.5\text{ \AA}$ ) hydrogen Balmer  $\alpha$  line broadening was

recorded, of constant width, up to 5 cm from the microwave coupler. Only hydrogen, and not oxygen, showed significant line broadening. This feature, observed previously in hydrogen-containing mixed gas plasmas generated with high voltage DC and RF discharges was explained by some researchers to result from acceleration of hydrogen ions near the cathode. This explanation cannot apply to the line broadening observed in the (electrodeless) microwave plasmas generated in this work, particularly at distances as great as 5 cm from the microwave coupler. Second, dramatic inversion of the line intensities of both the Lyman and Balmer series, again, at distances up to 5 cm from the coupler were observed. The dramatic line inversion suggests the existence of a hitherto unknown source of pumping of the optical power in plasmas. Finally, it is notable that other aspects of the plasma including the  $OH^*$  rotational temperature and low electron concentrations are quite typical of plasmas of this type.

**41. H. Conrads, R. Mills, Th. Wrubel, "Emission in the Deep Vacuum Ultraviolet from a Plasma Formed by Incandescently Heating Hydrogen Gas with Trace Amounts of Potassium Carbonate", Plasma Sources Science and Technology, Vol. 12, (2003), pp. 389-395.**

The generation of a hydrogen plasma with intense extreme ultraviolet and visible emission was observed at Ruhr University, Bochum, Germany from low pressure hydrogen gas (0.1-1 mbar) in contact with a hot tungsten filament only when the filament heated a titanium dissociator coated with  $K_2CO_3$  above 750°C. The dissociator was electrically floated, and the electric field strength from the filament was about 1 V/cm, two orders of magnitude lower than the starting voltages measured for gas glow discharges. The emission of the  $H_\alpha$  and  $H_\beta$  transitions as well as the  $L_\alpha$  and  $L_\beta$  transitions were recorded and analyzed. The plasma seemed to be far from thermal equilibrium, and no conventional mechanism was found to explain the formation of a hydrogen plasma by incandescently heating hydrogen gas with the presence of trace amounts of  $K_2CO_3$ . The temporal behavior of the plasma was recorded via hydrogen Balmer alpha line emission when all power into the cell was terminated. A two second decay of the plasma was observed after a fast decay of the electric field to zero. The

plasma was found to be dependent on the chemistry of atomic hydrogen with potassium since no plasma formed with  $Na_2CO_3$  replacing  $K_2CO_3$  and the time constant of the emission following the removal of all of the power to the cell matched that of the cooling of the filament and the resulting shift from atomic to molecular hydrogen. Our results indicate that a novel chemical power source is present that forms the energetic hydrogen plasma. The plasma is a potential new light source.

**40. R. Mills, "Observation of Extreme Ultraviolet Emission from Hydrogen-KI Plasmas Produced by a Hollow Cathode Discharge", Int. J. Hydrogen Energy, Vol. 26, No. 6, (2001), pp. 579-592.**

A high voltage discharge of hydrogen with and without the presence of a source of potassium, potassium iodide, in the discharge was performed at Institut für Niedertemperatur-Plasmaphysik e.V. (INP Greifswald, Germany) with a hollow cathode. It has been reported that intense extreme ultraviolet (EUV) emission was observed at low temperatures (e.g.  $< 10^3 K$ ) from atomic hydrogen and certain atomized elements or certain gaseous ions which ionize at integer multiples of the potential energy of atomic hydrogen,  $27.2 eV$  [1, 3-5]. Two potassium ions or a potassium atom may each provide an electron ionization or transfer reaction that has a net enthalpy equal to an integer multiple of  $27.2 eV$ . The spectral lines of atomic hydrogen were intense enough to be recorded on photographic films only when  $KI$  was present. EUV lines not assignable to potassium, iodine, or hydrogen were observed at 73.0, 132.6, 513.6, 677.8, 885.9, and 1032.9 Å. The lines are assigned to transitions of atomic hydrogen to lower energy levels corresponding to lower energy hydrogen atoms called hydrino atoms and the emission from the excitation of the corresponding hydride ions formed from the hydrino atoms.

**39. R. Mills, "Temporal Behavior of Light-Emission in the Visible Spectral Range from a  $Ti-K_2CO_3$ -H-Cell", Int. J. Hydrogen Energy, Vol. 26, No. 4, (2001), pp. 327-332.**

Institut für Niedertemperatur-Plasmaphysik e.V. (INP Greifswald, Germany) reports the generation of a hydrogen plasma and extreme ultraviolet emission as recorded via the hydrogen Balmer emission in the visible range. Typically a hydrogen plasma is generated and the emission of extreme ultraviolet light from hydrogen gas is achieved via a discharge at high voltage, a high power inductively coupled plasma, or a plasma created and heated to extreme temperatures by RF coupling (e.g.  $> 10^6 K$ ) with confinement provided by a toroidal magnetic field. The observed plasma formed at low temperatures (e.g.  $\approx 10^3 K$ ) from atomic hydrogen generated at a tungsten filament that heated a titanium dissociator coated with potassium carbonate. The temporal behavior of the plasma was recorded via hydrogen Balmer alpha line emission when all power into the cell was terminated. A two second decay of the plasma was observed after a fast decay of the electric field to zero. The persistence of emission following the removal of all of the power to the cell indicates that a novel chemical power source is present that forms an energetic plasma in hydrogen. No unusual behavior was observed with the control sodium carbonate.

**38. R. Mills, J. Sankar, A. Voigt, J. He, P. Ray, B. Dhandapani, "Synthesis and Characterization of Diamond Films from MPCVD of an Energetic Argon-Hydrogen Plasma and Methane", Materials Science, submitted.**

Polycrystalline diamond films were synthesized on silicon substrates by a low power ( $\sim 80 W$ ) microwave plasma chemical vapor deposition (MPCVD) reaction of a mixture of argon-hydrogen-methane (17.5/80/2.5%). The films were characterized by time of flight secondary ion mass spectroscopy (ToF-SIMS), X-ray photoelectron spectroscopy (XPS) (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA), Raman spectroscopy (Charles Evans & Associates, Sunnyvale, CA), scanning electron microscopy (SEM) (S. S. W., University of Western Ontario, Canada), and X-ray diffraction (XRD) (IC Laboratories, Amawalk, NY). It is proposed that  $Ar^+$  served as a catalyst with atomic hydrogen to form an energetic plasma.  $CH$ ,  $C_2$ , and  $C_3$  emissions were observed with significantly broadened  $H \alpha$  line. The average hydrogen atom temperature of a argon-hydrogen-methane plasma

was measured to be 110 - 130  $eV$  versus  $\approx 3 eV$  for pure hydrogen. Bombardment of the carbon surface by highly energetic hydrogen formed by the catalysis reaction may play a role in the formation of diamond. Then, by this novel pathway, the relevance of the  $CO$  tie line is eliminated along with other stringent conditions and complicated and inefficient techniques which limit broad application of the versatility and superiority of diamond thin film technology.

37. R. Mills, P. Ray, B. Dhandapani, W. Good, P. Jansson, M. Nansteel, J. He, A. Voigt, "Spectroscopic and NMR Identification of Novel Hydride Ions in Fractional Quantum Energy States Formed by an Exothermic Reaction of Atomic Hydrogen with Certain Catalysts", J. Phys. Chem. A, submitted.

$2K^+$  to  $K + K^{2+}$  and  $K$  to  $K^{3+}$  provide a reaction with a net enthalpy equal to the one and three times the potential energy of atomic hydrogen, respectively. The presence of these gaseous ions or atoms with thermally dissociated hydrogen formed a so-called resonance transfer (rt) plasma having strong VUV emission with a stationary inverted Lyman population. Significant line broadening of the Balmer  $\alpha$ ,  $\beta$ , and  $\gamma$  lines of 18 eV was observed, compared to 3 eV from a hydrogen microwave plasma. Emission from rt-plasmas occurred even when the electric field applied to the plasma was zero as recorded at Institut für Niedertemperatur-Plasmaphysik e.V. (INP Greifswald, Germany. The reaction was exothermic since excess power of 20  $mW \cdot cm^{-3}$  was measured by Calvet calorimetry. An energetic catalytic reaction was proposed involving a resonant energy transfer between hydrogen atoms and  $2K^+$  or  $K$  to form very stable novel hydride ions  $H^-(1/p)$  called hydrino hydrides having a fractional principal quantum numbers  $p = 2$  and  $p = 4$ , respectively. Characteristic emission was observed from  $K^{2+}$  and  $K^{3+}$  that confirmed the resonant nonradiative energy transfer of 27.2  $eV$  and  $3 \cdot 27.2 eV$  from atomic hydrogen to  $2K^+$  and  $K$ , respectively.

The predicted binding energy of  $H^-(1/2)$  of 3.0471  $eV$  with the fine structure was observed at 4071 Å, and its predicted bound-free hyperfine structure lines

$E_{HF} = j^2 3.00213 \times 10^{-5} + 3.0563 eV$  ( $j$  is an integer) matched those observed for  $j = 1$  to

$j = 37$  to within a 1 part per  $10^4$ .  $H^-(1/4)$  was observed spectroscopically at 110 nm corresponding to its predicted binding energy of 11.2 eV. The  $^1H$  MAS NMR spectrum (Spectral Data Services, Inc., Champaign, IL) of novel compound  $KH^*Cl$  relative to external tetramethylsilane (TMS) showed a large distinct upfield resonance at -4.4 corresponding to an absolute resonance shift of -35.9 ppm that matched the theoretical prediction of  $p = 4$ . A novel NMR (Grace Davison, Columbia, MD and Spectral Data Services, Inc., Champaign, IL) peak of  $KH^*I$  at -1.5 ppm relative to TMS corresponding to an absolute resonance shift of -33.0 ppm matched the theoretical prediction of  $p = 2$ . The predicted catalyst reactions, position of the upfield-shifted NMR peaks, and spectroscopic data for  $H^-(1/2)$  and  $H^-(1/4)$  were found to be in agreement.

**36. R. L. Mills, P. Ray, B. Dhandapani, J. He, "Novel Liquid-Nitrogen-Condensable Molecular Hydrogen Gas", Acta Physica Polonica A, submitted.**

Extreme ultraviolet (EUV) spectroscopy was recorded on microwave discharges of helium with 2% hydrogen. Novel emission lines were observed with energies of  $q \cdot 13.6$  eV where  $q = 1, 2, 3, 4, 6, 7, 8, 9, 11$  or these discrete energies less 21.2 eV corresponding to inelastic scattering of these photons by helium atoms due to excitation of  $He(1s^2)$  to  $He(1s^1 2p^1)$ . These lines matched  $H(1/p)$ , fractional Rydberg states of atomic hydrogen, formed by a resonant nonradiative energy transfer to  $He^+$ .

Corresponding emission due to the reaction  $2H(1/2) \rightarrow H_2(1/2)$  with vibronic coupling at

$$E_{D+vib} = p^2 E_{D H_2} \pm \left( \frac{\nu^*}{3} \right) E_{vib H_2(\nu=0 \rightarrow \nu=1)}, \quad \nu^* = 1, 2, 3, \dots$$

was observed at the longer

wavelengths for  $\nu^* = 2$  to  $\nu^* = 32$  and at the shorter wavelengths for  $\nu^* = 1$  to  $\nu^* = 16$  where  $E_{D H_2}$  and  $E_{vib H_2(\nu=0 \rightarrow \nu=1)}$  are the experimental bond and vibrational energies of  $H_2$ , respectively. Fractional-principal-quantum-level molecular hydrogen  $H_2(1/p)$  gas was isolated by liquefaction using an ultrahigh-vacuum, liquid nitrogen cryotrap and was characterized by gas chromatography (GC), mass spectroscopy (MS), optical emission spectroscopy (OES), and  $^1H$  NMR (Rider University, Lawrenceville NJ) of the condensable gas dissolved in  $CDCl_3$ . The condensable gas was highly pure hydrogen

by GC and MS and had a higher ionization energy than  $H_2$ . An upfield shifted NMR peaks were observed at 3.47 and 2.18 ppm compared to that of  $H_2$  at 4.63 ppm. A theoretical rocketry propellant reaction is given that may be transformational.

35. R. L. Mills, J. Sankar, A. Voigt, J. He, B. Dhandapani, "Spectroscopic Characterization of the Atomic Hydrogen Energies and Densities and Carbon Species During Helium-Hydrogen-Methane Plasma CVD Synthesis of Single Crystal Diamond Films", *Chemistry of Materials*, Vol. 15, (2003), pp. 1313-1321.

Polycrystalline diamond films were synthesized on silicon substrates for the first time without diamond seeding by a very low power (38 W) microwave plasma continuous vapor deposition (MPCVD) reaction of a mixture of helium-hydrogen-methane (48.2/48.2/3.6%). The films were characterized by time of flight secondary ion mass spectroscopy (ToF-SIMS), X-ray photoelectron spectroscopy (XPS) (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA), Raman spectroscopy (Charles Evans & Associates, Sunnyvale, CA and Jobin Yvon Inc., Edison, NJ), scanning electron microscopy (SEM) (S. S. W., University of Western Ontario, Canada and Material Testing Laboratory, Pennington, NJ), and X-ray diffraction (XRD) (IC Laboratories, Amawalk, NY). It is proposed that  $He^+$  served as a catalyst with atomic hydrogen to form an energetic plasma.  $CH$ ,  $C_2$ , and  $C_3$  emissions were observed with significantly broadened H  $\alpha$ ,  $\beta$ ,  $\gamma$ , and  $\delta$  lines. The average hydrogen atom temperature of a helium-hydrogen-methane plasma was measured to be 120 - 140 eV versus  $\approx 3$  eV for pure hydrogen. Bombardment of the carbon surface by highly energetic hydrogen formed by the catalysis reaction may play a role in the formation of diamond. Then, by this novel pathway, the relevance of the CO tie line is eliminated along with other stringent conditions and complicated and inefficient techniques which limit broad application of the versatility and superiority of diamond thin film technology.

**34. R. L. Mills, J. Sankar, A. Voigt, J. He, B. Dhandapani, "Low Power MPCVD of Diamond Films on Silicon Substrates", Journal of Vacuum Science & Technology A, submitted.**

Polycrystalline diamond films were synthesized on silicon substrates for the first time without diamond seeding by a very low power (38 W) microwave plasma continuous vapor deposition (MPCVD) reaction of a mixture of 10-30% hydrogen, 90-70% helium, and 1-10%  $CH_4$ . The films were characterized by time of flight secondary ion mass spectroscopy (ToF-SIMS), X-ray photoelectron spectroscopy (XPS) (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA), Raman spectroscopy (Charles Evans & Associates, Sunnyvale, CA), scanning electron microscopy (SEM) (S. S. W., University of Western Ontario, Canada and Material Testing Laboratory, Pennington, NJ), and X-ray diffraction (XRD) (IC Laboratories, Amawalk, NY). It is proposed that  $He^+$  served as a catalyst with atomic hydrogen to form an energetic plasma. The average hydrogen atom temperature was measured to be 180 - 210 eV versus  $\approx 3$  eV for pure hydrogen. The electron temperature  $T_e$  for helium-hydrogen was 28,000 K compared to 6800 K for pure helium. Bombardment of the carbon surface by highly energetic hydrogen formed by the catalysis reaction may play a role in the formation of diamond. Then, by this novel pathway, the relevance of the CO tie line is eliminated along with other stringent conditions and complicated and inefficient techniques which limit broad application of the versatility and superiority of diamond thin film technology.

**33. R. L. Mills, A. Voigt, B. Dhandapani, J. He, "Synthesis and Spectroscopic Identification of Lithium Chloro Hydride", Materials Characterization, submitted.**

A novel inorganic hydride compound, lithium chloro hydride ( $LiHCl$ ), which comprises a high binding energy hydride ion was synthesized by reaction of atomic hydrogen with potassium metal and lithium chloride. Lithium chloro hydride was identified by time of flight secondary ion mass spectroscopy, X-ray photoelectron spectroscopy (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh



University, Bethlehem, PA),  $^1H$  nuclear magnetic resonance spectroscopy (Spectral Data Services, Inc., Champaign, IL), and powder X-ray diffraction (IC Laboratories, Amawalk, NY). Hydride ions with increased binding energies may form many novel compounds with broad applications such as the oxidant of a high voltage battery.

**32. R. L. Mills, B. Dhandapani, J. He, "Highly Stable Amorphous Silicon Hydride", *Solar Energy Materials & Solar Cells*, Vol. 80, No. 1, (2003), pp. 1-20.**

A novel highly stable hydrogen terminated silicon coating was synthesized by microwave plasma reaction of mixture of silane, hydrogen, and helium wherein it is proposed that  $He^+$  served as a catalyst with atomic hydrogen to form highly stable silicon hydrides. Novel silicon hydride was identified by time of flight secondary ion mass spectroscopy and X-ray photoelectron spectroscopy. The time of flight secondary ion mass spectroscopy (ToF-SIMS) identified the coatings as hydride by the large  $SiH^+$  peak in the positive spectrum and the dominant  $H^-$  in the negative spectrum. Since hydrogen is the only element with no primary element peaks, X-ray photoelectron spectroscopy (XPS) (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA) identified the  $H$  content of the  $SiH$  coatings as comprising novel silicon hydrides due to new peaks at 11, 43, and 55 eV in the absence of corresponding peaks of any candidate element at higher binding energies. The silicon hydride surface was remarkably stable to air as shown by XPS. The highly stable amorphous silicon hydride coating may advance the production of integrated circuits and microdevices by resisting the oxygen passivation of the surface and possibly altering the dielectric constant and band gap to increase device performance.

**31. R. L. Mills, J. Sankar, A. Voigt, J. He, B. Dhandapani, "Synthesis of HDLC Films from Solid Carbon", *Thin Solid Films*, submitted.**

Diamond-like carbon (DLC) films were synthesized on silicon substrates from solid carbon by a very low power (~60 W) microwave plasma chemical vapor deposition (MPCVD) reaction of a mixture of 90-70% helium and 10-30% hydrogen. It is proposed that  $He^+$  served as a catalyst with atomic hydrogen to form an energetic plasma. The

average hydrogen atom temperature of a helium-hydrogen plasma was measured to be 180 - 210 eV versus  $\approx 3$  eV for pure hydrogen. Bombardment of the carbon surface by highly energetic hydrogen formed by the catalysis reaction may play a role in the formation of DLC. The films were characterized by time of flight secondary ion mass spectroscopy (ToF-SIMS), X-ray photoelectron spectroscopy (XPS) (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA), and Raman spectroscopy (Charles Evans & Associates, Sunnyvale, CA). TOF-SIMS identified the coatings as hydride by the large  $H^+$  peak in the positive spectrum and the dominant  $H^-$  in the negative spectrum. The XPS identification of the  $H$  content of the  $CH$  coatings as a novel hydride corresponding to a peak at 49 eV has implications that the mechanism of the DLC formation may also involve one or both of selective etching of graphitic carbon and the stabilization of  $sp^3$ -bonded carbon by the hydrogen catalysis product. Thus, a novel  $H$  intermediate formed by the plasma catalysis reaction may enhance the stabilization and etching role of  $H$  used in past methods.

**30. R. L. Mills, J. He, P. Ray, B. Dhandapani, X. Chen, "Synthesis and Characterization of a Highly Stable Amorphous Silicon Hydride as the Product of a Catalytic Helium-Hydrogen Plasma Reaction", Int. J. Hydrogen Energy, in press.**

A novel highly stable surface coating  $SiH(1/p)$  which comprised high binding energy hydride ions was synthesized by a microwave plasma reaction of a mixture of silane, hydrogen, and helium wherein it is proposed that  $He^+$  served as a catalyst with atomic hydrogen to form the highly stable hydride ions. Novel silicon hydride was identified by time of flight secondary ion mass spectroscopy and X-ray photoelectron spectroscopy. The time of flight secondary ion mass spectroscopy (ToF-SIMS) identified the coatings as hydride by the large  $SiH^+$  peak in the positive spectrum and the dominant  $H^-$  in the negative spectrum. X-ray photoelectron spectroscopy (XPS) (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA) identified the  $H$  content of the  $SiH$  coatings as hydride ions,  $H^-(1/4)$ ,  $H^-(1/9)$ , and  $H^-(1/11)$  corresponding to peaks at 11, 43, and 55 eV, respectively. The

silicon hydride surface was remarkably stable to air as shown by XPS. The highly stable amorphous silicon hydride coating may advance the production of integrated circuits and microdevices by resisting the oxygen passivation of the surface and possibly altering the dielectric constant and band gap to increase device performance.

The plasma which formed  $SiH(1/p)$  showed a number of extraordinary features. Novel emission lines with energies of  $q \cdot 13.6 \text{ eV}$  where  $q = 1, 2, 3, 4, 6, 7, 8, 9, \text{ or } 11$  were previously observed by extreme ultraviolet (EUV) spectroscopy recorded on microwave discharges of helium with 2% hydrogen [R. Mills, P. Ray, "Spectral Emission of Fractional Quantum Energy Levels of Atomic Hydrogen from a Helium-Hydrogen Plasma and the Implications for Dark Matter", Int. J. Hydrogen Energy, Vol. 27, No. 3, pp. 301-322]. These lines matched  $H(1/p)$ , fractional Rydberg states of atomic hydrogen where  $p$  is an integer, formed by a resonant nonradiative energy transfer to  $He^+$  acting as a catalyst. The average hydrogen atom temperature of the helium-hydrogen plasma was measured to be 180-210 eV versus  $\approx 3 \text{ eV}$  for pure hydrogen. Using water bath calorimetry, excess power was observed from the helium-hydrogen plasma compared to control krypton plasma. For example, for an input of 8.1 W, the total plasma power of the helium-hydrogen plasma measured by water bath calorimetry was 30.0 W corresponding to 21.9 W of excess power in  $3 \text{ cm}^3$ . The excess power density and energy balance were high,  $7.3 \text{ W/cm}^3$  and  $-2.9 \times 10^4 \text{ kJ/mole } H_2$ , respectively. This catalytic plasma reaction may represent a new hydrogen energy source and a new field of hydrogen chemistry.

**29. R. L. Mills, A. Voigt, B. Dhandapani, J. He, "Synthesis and Characterization of Lithium Chloro Hydride", Int. J. Hydrogen Energy, submitted.**

A novel inorganic hydride compound lithium chloro hydride,  $LiHCl$ , which comprises a high binding energy hydride ion was synthesized by reaction of atomic hydrogen with potassium metal and lithium chloride. Lithium chloro hydride was identified by time of flight secondary ion mass spectroscopy, X-ray photoelectron spectroscopy (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA),  $^1H$  nuclear magnetic resonance spectroscopy (Spectral

Data Services, Inc., Champaign, IL), and powder X-ray diffraction (IC Laboratories, Amawalk, NY). Hydride ions with increased binding energies may form many novel compounds with broad applications such as the oxidant of a high voltage battery.

**28. R. Mills, E. Dayalan, P. Ray, B. Dhandapani, J. He, "Highly Stable Novel Inorganic Hydrides from Aqueous Electrolysis and Plasma Electrolysis", *Electrochimica Acta*, Vol. 47, No. 24, (2002), pp. 3909-3926.**

After  $10^4$  hours of continuous aqueous electrolysis with  $K_2CO_3$  as the electrolyte, highly stable novel inorganic hydride compounds such as  $KH$  and  $KHCO_3$  were isolated and identified by time of flight secondary ion mass spectroscopy (ToF-SIMS) (Charles Evans East, East Windsor, NJ). The existence of novel hydride ions was determined using X-ray photoelectron spectroscopy (XPS) (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA) and solid state magic-angle spinning  $^1H$  nuclear magnetic resonance spectroscopy ( $^1H$  MAS NMR) (Spectral Data Services, Inc., Champaign, IL). A novel ion formed by plasma electrolysis of a  $K_2CO_3$ ,  $Rb_2CO_3$ , or  $Cs_2CO_3$  electrolyte was also observed by high resolution visible spectroscopy at 407.0 nm corresponding to its predicted binding energy of 3.05 eV.

**27. R. Mills, B. Dhandapani, M. Nansteel, J. He, A. Voigt, "Identification of Compounds Containing Novel Hydride Ions by Nuclear Magnetic Resonance Spectroscopy", *Int. J. Hydrogen Energy*, Vol. 26, No. 9, Sept. (2001), pp. 965-979.**

Novel inorganic alkali and alkaline earth hydrides of the formula  $MH^*$ ,  $MH_2^*$ , and  $MH^*X$  wherein  $M$  is the metal,  $X$ , is a halide, and  $H^*$  comprises a novel high binding energy hydride ion were synthesized in a high temperature gas cell by reaction of atomic hydrogen with a catalyst and  $MH$ ,  $MH_2$ , or  $MX$  corresponding to an alkali metal or alkaline earth metal compound, respectively. Novel hydride ions of the corresponding novel hydride compounds were characterized by an extraordinary upfield shifted peak observed by  $^1H$  nuclear magnetic resonance spectroscopy. The result

were confirmed on five different instruments at five independent laboratories (Spectral Data Services, Inc., Champaign, IL, National Research Council of Canada, University of Massachusetts Amherst, Amherst, MA, University of Delaware, Wilmington, DE, and Grace Davison, Columbia, MD).

26. R. Mills, B. Dhandapani, N. Greenig, J. He, "Synthesis and Characterization of Potassium Iodo Hydride", *Int. J. of Hydrogen Energy*, Vol. 25, Issue 12, December, (2000), pp. 1185-1203.

A novel inorganic hydride compound  $KHI$  which comprises a high binding energy hydride ion was synthesized by reaction of atomic hydrogen with potassium metal and potassium iodide. Potassium iodo hydride was identified by time of flight secondary ion mass spectroscopy, X-ray photoelectron spectroscopy (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA),  $^1H$  and  $^{39}K$  nuclear magnetic resonance spectroscopy (Spectral Data Services, Inc., Champaign, IL), Fourier transform infrared spectroscopy (Surface Science Laboratories, Mountain View, CA), electrospray ionization time of flight mass spectroscopy (Perkin-Elmer Biosystems, Framingham, MA), liquid chromatography/mass spectroscopy (Ricerca, Inc., Painesville, Ohio), thermal decomposition with analysis by gas chromatography, and mass spectroscopy, and elemental analysis (Galbraith Laboratories, Inc., Knoxville, TN). Hydride ions with increased binding energies may form many novel compounds with broad applications.

25. R. Mills, "Novel Inorganic Hydride", *Int. J. of Hydrogen Energy*, Vol. 25, (2000), pp. 669-683.

A novel inorganic hydride compound  $KH KHCO_3$  which is stable in water and comprises a high binding energy hydride ion was isolated following the electrolysis of a  $K_2CO_3$  electrolyte. Inorganic hydride clusters  $K[KH KHCO_3]^+$  were identified by Time of Flight Secondary Ion Mass Spectroscopy (Charles Evans East, East Windsor, NJ). Moreover, the existence of a novel hydride ion has been determined using X-ray photoelectron spectroscopy (Zettlemoyer Center for Surface Studies, Sinclair

Laboratory, Lehigh University, Bethlehem, PA), and  $^1H$  nuclear magnetic resonance spectroscopy (Spectral Data Services, Inc., Champaign, IL). Hydride ions with increased binding energies may be the basis of a high voltage battery for electric vehicles.

24. R. Mills, B. Dhandapani, M. Nansteel, J. He, T. Shannon, A. Echezuria, "Synthesis and Characterization of Novel Hydride Compounds", *Int. J. of Hydrogen Energy*, Vol. 26, No. 4, (2001), pp. 339-367.

Novel inorganic alkali and alkaline earth hydrides of the formula  $MHX$  and  $MHMX$  wherein  $M$  is the metal,  $X$ , is a singly negatively charged anion, and  $H$  comprises a novel high binding energy hydride ion were synthesized in a high temperature gas cell by reaction of atomic hydrogen with a catalyst and  $MX$  or  $MX_2$  corresponding to an alkali metal or alkaline earth metal, respectively. It has been reported that intense extreme ultraviolet (EUV) emission was observed at low temperatures (e.g.  $\approx 10^3 K$ ) from atomic hydrogen and certain atomized elements or certain gaseous ions which ionize at integer multiples of the potential energy of atomic hydrogen,  $27.2 eV$  [1-5]. These atomized elements or certain gaseous ions comprised the catalyst to form  $MHX$  and  $MHMX$ . For example, atomic hydrogen was reacted with strontium vapor and  $SrBr_2$  to form  $SrHBr$ . Novel hydride compounds such as  $SrHBr$  were identified by time of flight secondary ion mass spectroscopy, X-ray photoelectron spectroscopy (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA),  $^1H$  nuclear magnetic resonance spectroscopy (Spectral Data Services, Inc., Champaign, IL), and thermal decomposition with analysis by gas chromatography, and mass spectroscopy. Hydride ions with increased binding energies form novel compounds with potential broad applications such as a high voltage battery for consumer electronics and electric vehicles. In addition, these novel compositions of matter and associated technologies may have far-reaching applications in many industries including chemical, electronics, computer, military, energy, and aerospace in the form of products such as propellants, solid fuels, surface coatings, structural materials, and chemical processes.

**23. R. Mills, "Highly Stable Novel Inorganic Hydrides", Journal of New Materials for Electrochemical Systems, Vol. 6, (2003), pp. 45-54.**

Novel inorganic hydride compounds  $KH$  and  $KHCO_3$  were isolated following the electrolysis of a  $K_2CO_3$  electrolyte. The compounds which comprised high binding energy hydride ions were stable in water, and  $KH$  was stable at elevated temperature (600 °C). Inorganic hydride clusters  $K[KH(KHCO_3)]_n^+$  were identified by positive Time of Flight Secondary Ion Mass Spectroscopy (ToF-SIMS) of  $KH(KHCO_3)$  (Charles Evans East, East Windsor, NJ). The negative ToF-SIMS was dominated by hydride ion. The positive and negative ToF-SIMS of  $KH$  showed essentially  $K^+$  and  $H^-$  only, respectively. Moreover, the existence of novel hydride ions was determined using X-ray photoelectron spectroscopy (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA), and  $^1H$  nuclear magnetic resonance spectroscopy (Spectral Data Services, Inc., Champaign, IL). Hydride ions with increased binding energies may be the basis of a high voltage battery for electric vehicles.

**22. R. Mills, "Novel Hydrogen Compounds from a Potassium Carbonate Electrolytic Cell", Fusion Technology, Vol. 37, No. 2, March, (2000), pp. 157-182.**

Novel compounds containing hydrogen in new hydride and polymeric states which demonstrate novel hydrogen chemistry have been isolated following the electrolysis of a  $K_2CO_3$  electrolyte with the production of excess energy. Inorganic hydride clusters  $K[KH(KHCO_3)]_n^+$  and hydrogen polymer ions such as  $OH_{23}^+$  and  $H_{16}^-$  were identified by time of flight secondary ion mass spectroscopy (Charles Evans East, East Windsor, NJ). The presence of compounds containing new states of hydrogen were confirmed by X-ray photoelectron spectroscopy (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA), X-ray diffraction, Fourier transform infrared spectroscopy (Surface Science Laboratories, Mountain View, CA), Raman spectroscopy (Environmental Catalysis and Materials Laboratory of

Virginia Polytechnic Institute), and  $^1\text{H}$  nuclear magnetic resonance spectroscopy (Spectral Data Services, Inc., Champaign, IL).

**21. Mills, R., Good, W., "Fractional Quantum Energy Levels of Hydrogen", *Fusion Technology*, Vol. 28, No. 4, November, (1995), pp. 1697-1719.**

Determination of excess heat release during the electrolysis of aqueous potassium carbonate by the very accurate and reliable method of heat measurement, flow calorimetry; describes the experimental identification of hydrogen atoms in fractional quantum energy levels—hydrinos—by X-ray Photoelectron Spectroscopy (XPS) (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA); describes the experimental identification of hydrogen atoms in fractional quantum energy levels—hydrinos—by emissions of soft X-rays from dark matter; describes the experimental identification of hydrogen molecules in fractional quantum energy levels—dihyrino molecules by high resolution magnetic sector mass spectroscopy with ionization energy determination, and gives a summary.

In summary:

Excess power and heat were observed during the electrolysis of aqueous potassium carbonate. Flow calorimetry of pulsed current electrolysis of aqueous potassium carbonate at a nickel cathode was performed in a single-cell dewar. The average power out of 24.6 watts exceeded the average input power (voltage times current) of 4.73 watts by a factor greater than 5. The total input energy (integration of voltage times current) over the entire duration of the experiment was 5.72 MJ; whereas, the total output energy was 29.8 MJ. No excess heat was observed when the electrolyte was changed from potassium carbonate to sodium carbonate. The source of heat is assigned to the electrocatalytic, exothermic reaction whereby the electrons of hydrogen atoms are induced to undergo transitions to quantized energy levels below the conventional "ground state". These lower energy states correspond to fractional quantum numbers:  $n = 1/2, 1/3, 1/4, \dots$ . Transitions to these lower energy states are



stimulated in the presence of pairs of potassium ions ( $K^+/K^+$  electrocatalytic couple) which provide 27.2 eV energy sinks.

The identification of the  $n = 1/2$  hydrogen atom,  $H(n = 1/2)$  is reported. Samples of the nickel cathodes of aqueous potassium carbonate electrolytic cells and aqueous sodium carbonate electrolytic cells were analyzed by XPS (Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA). A broad peak centered at 54.6 eV was present only in the cases of the potassium carbonate cells. The binding energy (in vacuum) of  $H(n = 1/2)$  is 54.4 eV. Thus, the theoretical and measured binding energies for  $H(n = 1/2)$  are in excellent agreement.

Further experimental identification of hydrinos—down to  $H(n = 1/8)$ —can be found in the alternative explanation by Mills et al. for the soft X-ray emissions of the dark interstellar medium observed by Labov and Bowyer [Labov, S., Bowyer, S., "Spectral observations of the extreme ultraviolet background", The Astrophysical Journal, 371, (1991), pp. 810-819] of the Extreme UV Center of the University of California, Berkeley. The agreement between the experimental spectrum and the energy values predicted for the proposed transitions is remarkable.

The reaction product of two  $H(n=1/2)$  atoms, the dihydrino molecule, was identified by mass spectroscopy (Shrader Analytical & Consulting Laboratories). The mass spectrum of the cryofiltered gases evolved during the electrolysis of a light water  $K_2CO_3$  electrolyte with a nickel cathode demonstrated that the dihydrino molecule,  $H_2\left(n = \frac{1}{2}\right)$ , has a higher ionization energy, about 63 eV, than normal molecular hydrogen,  $H_2(n = 1)$ , 15.46 eV. The high resolution (0.001 AMU) magnetic sector mass spectroscopic analysis of the postcombustion gases indicated the presence of two peaks of nominal mass two-- one peak at 70 eV and one peak at 25 eV. The same analysis of molecular hydrogen indicates only one peak at 25 eV and one peak at 70 eV. In the case of the postcombustion sample at 70 eV, one peak was assigned as the hydrogen molecular ion peak,  $H_2^+(n = 1)$ , and one peak was assigned as the dihydrino molecular peak,  $H_2^+\left(n = \frac{1}{2}\right)$  which has a slightly larger magnetic moment.

20. Mills, R., Good, W., Shaubach, R., "Dihydrino Molecule Identification", **Fusion Technology, Vol. 25, 103 (1994).**

Calorimetry of pulsed current and continuous electrolysis of aqueous potassium carbonate ( $K^+/K^+$  electrocatalytic couple) at a nickel cathode was performed by Thermacore, Inc., Lancaster, PA. The excess power out of 41 watts exceeded the total input power given by the product of the electrolysis voltage and current by a factor greater than 8. Elemental analysis of the electrolyte and metallurgical analysis of the cathode showed no evidence of chemical reactions. The pH, specific gravity, concentration of  $K_2CO_3$ , and the elemental analysis of the electrolyte sample taken after 42 days of continuous operation were unchanged from that of the values obtained for the electrolyte sample taken before operation. Elemental analysis and scanning electron microscopy of metallurgical samples of the nickel cathode taken before operation and at day 56 of continuous operation were identical indicating that the nickel cathode had not changed chemically or physically. Scintillation counter and photographic film measurements showed that no radiation above background was detected indicating that nuclear reactions did not occur.

The "ash" of the exothermic reaction is atoms having electrons of energy below the "ground state" which are predicted to form molecules. The predicted molecules were identified by lack of reactivity with oxygen, by separation from molecular deuterium by cryofiltration, and by mass spectroscopic analysis. The combustion of the gases evolved during the electrolysis of a light water  $K_2CO_3$  electrolyte ( $K^+/K^+$  electrocatalytic couple) with a nickel cathode was incomplete. The mass spectroscopic analysis (Dr. David Parees of Air Products & Chemicals, Inc.) of the  $m/e = 2$  peak of the combusted gas demonstrated that the dihydrino molecule,  $H_2(n = 1/2)$ , has a higher ionization energy than  $H_2$ .

Calorimetry of pulsed current and continuous electrolysis of aqueous potassium carbonate ( $K^+/K^+$  electrocatalytic couple) at a nickel cathode was performed in single cell dewar calorimetry cells by HydroCatalysis Power Corporation. Excess power out exceeded input power by a factor greater than 16. No excess heat was observed when

the electrolyte was changed from potassium carbonate to the control sodium carbonate. The faraday efficiency was measured volumetrically to be 100%.

**19. V. Noninski, *Fusion Technol.*, Vol. 21, 163 (1992).**

Dr. Noninski of the Laboratory for Electrochemistry of Renewed Electrode-Solution Interface (LEPGER) successfully reproduced the results of Mills and Kneizys [R. Mills and S. Kneizys, *Fusion Technol.* Vol. 20, 65 (1991)] as a visiting professor at Franklin and Marshall College. A significant increase in temperature with every watt input, compared with the calibration experiment ( $\approx 50\text{ }^{\circ}\text{C} / \text{W}$  versus  $\approx 30\text{ }^{\circ}\text{C} / \text{W}$ ), was observed during the electrolysis of potassium carbonate. This effect was not observed when sodium carbonate was electrolyzed. No trivial explanation (in terms of chemical reactions, change in heat transfer properties, etc.) of this effect were found.

**18. Niedra, J., Meyers, I., Fralick, G. C., and Baldwin, R., "Replication of the Apparent Excess Heat Effect in a Light Water-Potassium Carbonate-Nickel Electrolytic Cell, NASA Technical Memorandum 107167, February, (1996). pp. 1-20.; Niedra, J., Baldwin, R., Meyers, I., NASA Presentation of Light Water Electrolytic Tests, May 15, 1994.**

NASA Lewis tested a cell identical to that of Thermacore [Mills, R., Good, W., Shaubach, R., "Dihydrino Molecule Identification", *Fusion Technology*, Vol. 25, 103 (1994)] with the exception that it was minus the central cathode. A cell identical to the test cell with heater power only (no electrolysis) was the calibration control and the blank cell with the heater power equal to zero. The test cell was also calibrated "on the fly" by measuring the temperature relative to the blank cell at several values of heater input power of the test cell. "Replication of experiments claiming to demonstrate excess heat production in light water-Ni-  $\text{K}_2\text{CO}_3$  electrolytic cells was found to produce an apparent excess heat of 11 W maximum, for 60 W electrical power into the cell. Power gains ranged from 1.06 to 1.68." The production of excess energy with a power gain of 1.68 would require 0% Faraday efficiency to account for the observed excess power.

**17. Technology Insights, 6540 Lusk Boulevard, Suite C-102, San Diego, CA 92121, "HydroCatalysis Technical Assessment Prepared for PacifiCorp", August 2, 1996.**

This report documents a technical assessment of a novel source of hydrogen energy advanced by HydroCatalysis Power Corporation now BlackLight Power, Inc. (BLP). The assessment was conducted as part of the due diligence performed for PacifiCorp. It was conducted by a literature search and review, site visits to BLP and collaborating organizations, and telephone interviews with others active in the general area. A description of concept is provided in Section 3. Section 4 presents an assessment of the concept background, supporting theory, laboratory prototypes, projected initial products, and economic and environmental aspects. Section 5 documents the results of telephone interviews and site visits. An overall summary and conclusions are presented in the following section.

**16. P. M. Jansson, "HydroCatalysis: A New Energy Paradigm for the 21st Century", Thesis Submitted in partial fulfillment of the requirements of the Masters of Science in Engineering Degree in the Graduate Division of Rowan University, May 1997, Thesis Advisors: Dr. J. L. Schmalzel, Dr. T. R. Chandrupatla, and Dr. A. J. Marchese, External Advisors: Dr. J. Phillips, Pennsylvania State University, Dr. R. L. Mills, BlackLight Power, Inc., W. R. Good, BlackLight Power, Inc.**

This thesis reviews the problems of worldwide energy supply, describes the current technologies that meet the energy needs of our industrial societies, summarizes the environmental impacts of those fuels and technologies and their increased use by a growing global and increasing technical economy. The work also describes and advances the technology being developed by BlackLight Power, Inc. (BLP) a scientific company located in Princeton, New Jersey. BLP's technology proports to offer commercially viable and useful heat generation via a previously unrecognized natural phenomenon - the catalytic reduction of the hydrogen atom to a lower energy state. Laboratory tests obtained as original research of this thesis as well as the review of the data of others substantiate the fact that replication of the experimental conditions which

are favorable to initiating and sustaining the new energy release process will generate controllable, reproducible, sustainable and commercial meaningful heat. For example, Jansson has determined heat production associated with hydrino formation with a Calvet calorimeter which yielded exceptional results. Specifically, the results are completely consistent with Mills hydrino formation hypothesis. Approximately  $10^{-3}$  moles of hydrogen was admitted to a  $20\text{ cm}^3$  Calvet cell containing a heated platinum filament and  $KNO_3$  powder. In the three separate trials with a platinum filament hydrogen dissociator which was varied in length of 10 cm, 20 cm, and 30 cm, a mean power of 0.581, 0.818, and 1.572 watts was observed, respectively. The closed experiments were run to completion. The energy observed was 622, 369, and 747 kJ, respectively, This is equivalent to the generation of  $6.2 \times 10^8\text{ J/mole}$ ,  $3.7 \times 10^8\text{ J/mole}$ , and  $7.5 \times 10^8\text{ J/mole}$  of hydrogen, respectively, as compared to  $2.5 \times 10^5\text{ J/mole}$  of hydrogen anticipated for standard hydrogen combustion. Thus, the total heats generated appear to be at least 1000 times too large to be explained by conventional chemistry, but the results are completely consistent with Mills model. Convincing evidence is presented to lead to the conclusion that BLP technology has tremendous potential to achieve commercialization and become an energy paradigm for the next century. The research was also conducted as part of the due diligence performed for Atlantic Energy now Conectiv.

- 15. Phillips, J., Smith, J., Kurtz, S., "Report On Calorimetric Investigations Of Gas-Phase Catalyzed Hydrino Formation" Final report for Period October-December 1996", January 1, 1997, A Confidential Report submitted to BlackLight Power, Inc. provided by BlackLight Power, Inc., Great Valley Corporate Center, 41 Great Valley Parkway, Malvern, PA 19355.**

Pennsylvania State University Chemical Engineering Department has determined heat production associated with hydrino formation with a Calvet calorimeter which yielded exceptional results. Specifically, the results are completely consistent with Mills hydrino formation hypothesis. In three separate trials, between 10 and 20 K Joules were generated at a rate of 0.5 Watts, upon admission of approximately  $10^{-3}$  moles of

hydrogen to the  $20 \text{ cm}^3$  Calvet cell containing a heated platinum filament and  $\text{KNO}_3$  powder. This is equivalent to the generation of  $10^7 \text{ J/mole}$  of hydrogen, as compared to  $2.5 \times 10^5 \text{ J/mole}$  of hydrogen anticipated for standard hydrogen combustion. Thus, the total heats generated appear to be 100 times too large to be explained by conventional chemistry, but the results are completely consistent with Mills model.

14. **Phillips, J., Shim, H., "Additional Calorimetric Examples of Anomalous Heat from Physical Mixtures of K/Carbon and Pd/Carbon", January 1, 1996, A Confidential Report submitted to HydroCatalysis Power Corporation provided by HydroCatalysis Power Corporation, Great Valley Corporate Center, 41 Great Valley Parkway, Malvern, PA 19355.**

Pennsylvania State University Chemical Engineering Department has determined excess heat release from flowing hydrogen in the presence of ionic hydrogen spillover catalytic material: 40% by weight potassium nitrate ( $\text{KNO}_3$ ) on graphitic carbon powder with 5% by weight 1%-Pd-on-graphitic carbon ( $\text{K}^+/\text{K}^+$  electrocatalytic couple) by the very accurate and reliable method of heat measurement, thermopile conversion of heat into an electrical output signal. Excess power and heat were observed with flowing hydrogen over the catalyst. However, no excess power was observed with flowing helium over the catalyst mixture. Rates of heat production were reproducibly observed which were higher than that expected from the conversion of all the hydrogen entering the cell to water, and the total energy observed was over four times larger than that expected if all the catalytic material in the cell were converted to the lowest energy state by "known" chemical reactions. Thus, "anomalous" heat, heat of a magnitude and duration which could not be explained by conventional chemistry, was reproducibly observed.

13. **Bradford, M. C., Phillips, J., "A Calorimetric Investigation of the Reaction of Hydrogen with Sample PSU #1", September 11, 1994, A Confidential Report submitted to HydroCatalysis Power Corporation provided by HydroCatalysis**

**Power Corporation, Great Valley Corporate Center, 41 Great Valley Parkway,  
Malvern, PA 19355.**

Pennsylvania State University Chemical Engineering Department has determined excess heat release from flowing hydrogen in the presence of nickel oxide powder containing strontium niobium oxide ( $\text{Nb}^{3+}/\text{Sr}^{2+}$  electrocatalytic couple) by the very accurate and reliable method of heat measurement, thermopile conversion of heat into an electrical output signal. Excess power and heat were observed with flowing hydrogen over the catalyst which increased with increasing flow rate. However, no excess power was observed with flowing helium over the catalyst/nickel oxide mixture or flowing hydrogen over nickel oxide alone. Approximately 10 cc of nickel oxide powder containing strontium niobium oxide immediately produced 0.55 W of steady state output power at 523 K. When the gas was switched from hydrogen to helium, the power immediately dropped. The switch back to hydrogen restored the excess power output which continued to increase until the hydrogen source cylinder emptied at about the 40,000 second time point. With no hydrogen flow the output power fell to zero.

The source of heat is assigned to the electrocatalytic, exothermic reaction whereby the electrons of hydrogen atoms are induced to undergo transitions to quantized energy levels below the conventional "ground state". These lower energy states correspond to fractional quantum numbers:  $n = 1/2, 1/3, 1/4, \dots$ . Transitions to these lower energy states are stimulated in the presence of pairs of niobium and strontium ions ( $\text{Nb}^{3+}/\text{Sr}^{2+}$  electrocatalytic couple) which provide 27.2 eV energy sinks.

**12. Jacox, M. G., Watts, K. D., "The Search for Excess Heat in the Mills Electrolytic Cell", Idaho National Engineering Laboratory, EG&G Idaho, Inc., Idaho Falls, Idaho, 83415, January 7, 1993.**

Idaho National Engineering Laboratory (INEL) operated a cell identical to that of Thermacore [Mills, R., Good, W., Shaubach, R., "Dihydrino Molecule Identification", Fusion Technology, Vol. 25, 103 (1994)] except that it was minus the central cathode and that the cell was wrapped in a one-inch layer of urethane foam insulation about the cylindrical surface. The cell was operated in a pulsed power mode. A current of 10

amperes was passed through the cell for 0.2 seconds followed by 0.8 seconds of zero current for the current cycle. The cell voltage was about 2.4 volts, for an average input power of 4.8 W. The electrolysis power average was 1.84 W, and the stirrer power was measured to be 0.3 W. Thus, the total average net input power was 2.14 W. The cell was operated at various resistance heater settings, and the temperature difference between the cell and the ambient as well as the heater power were measured. The results of the excess power as a function of cell temperature with the cell operating in the pulsed power mode at 1 Hz with a cell voltage of 2.4 volts, a peak current of 10 amperes, and a duty cycle of 20 % showed that the excess power is temperature dependent for pulsed power operation, and the maximum excess power was 18 W for an input electrolysis joule heating power of 2.14 W. Thus, the ratio of excess power to input electrolysis joule heating power was 850 %. INEL scientists constructed an electrolytic cell comprising a nickel cathode, a platinized titanium anode, and a 0.57 M  $K_2CO_3$  electrolyte. The cell design appears in Appendix 1. The cell was operated in the environmental chamber in the INEL Battery Test Laboratory at constant current, and the heat was removed by forced air convection in two cases. In the first case, the air was circulated by the environmental chamber circulatory system alone. In the second case, an additional forced air fan was directed onto the cell. The cell was equipped with a water condenser, and the water addition to the cell due to electrolysis losses was measured. The data of the forced convection heat loss calorimetry experiments during the electrolysis of a 0.57 M  $K_2CO_3$  electrolyte with the INEL cell showed that 13 W of excess power was produced. This excess power could not be attributed to recombination of the hydrogen and oxygen as indicated by the equivalence of the calculated and measured water balance.

**11. Peterson, S., H., Evaluation of Heat Production from Light Water Electrolysis Cells of HydroCatalysis Power Corporation, Report from Westinghouse STC, 1310 Beulah Road, Pittsburgh, PA, February 25, 1994.**

Westinghouse Electric Corporation reports that excess heat was observed during the electrolysis of aqueous potassium carbonate ( $K^+/K^+$  electrocatalytic couple) where



the electrolysis of aqueous sodium carbonate served as the control. The data of the temperature of the cell minus the ambient temperature shows that when potassium carbonate replaced sodium carbonate in the same cell with the same input electrolysis power, the potassium experiment was twice as hot as the sodium carbonate experiment for the duration of the experiment, one month. The net faraday efficiency of gas evolution was experimentally measured to be unity by weighing the experiment to determine that the expected rate of water consumption was observed. The output power exceeded the total input power. The data was analyzed by HydroCatalysis Power Corporation [Mills, R., Analysis by HydroCatalysis Power Corporation of Westinghouse Report Entitled "Evaluation of Heat Production from Light Water Electrolysis Cells of HydroCatalysis Power Corporation, Report from Westinghouse STC", February 25, 1994].

**10. Haldeman, C. W., Savoye, G. W., Iseler, G. W., Clark, H. R., MIT Lincoln Laboratories Excess Energy Cell Final report ACC Project 174 (3), April 25, 1995.**

During the electrolysis of aqueous potassium carbonate, researchers working at MIT Lincoln Laboratories observed long duration excess power of 1-5 watts with output/input ratios over 10 in some cases with respect to the cell input power reduced by the enthalpy of the generated gas. In these cases, the output was 1.5 to 4 times the integrated volt-ampere power input. Faraday efficiency was measured volumetrically by direct water displacement.

**9. Craw-Ivanco, M. T.; Tremblay, R. P.; Boniface, H. A.; Hilborn, J. W.; "Calorimetry for a Ni/ $K_2CO_3$  Cell", Atomic Energy Canada Limited, Chemical Engineering Branch, Chalk River Laboratories, Chalk River, Ontario, June 1994.**

Atomic Energy Canada Limited, Chalk River Laboratories, report that 128 % and 138% excess heat were observed in separate experiments by flow calorimetry during the electrolysis of aqueous potassium carbonate ( $K^+/K^+$  electrocatalytic couple) in a closed cell, and that 138% was observed in an open cell.

**8. Shaubach, R. M., Gernert, N. J., "Anomalous Heat From Hydrogen in Contact with Potassium Carbonate", Thermacore Report, March 1994.**

A high temperature/high pressure/high power density industrial prototype gas cell power generator which produced 50 watts of power at 300 °C having a nickel surface area of only 300 cm<sup>2</sup> was successfully developed. A sample of the nickel tubing of the aqueous potassium carbonate permeation cell was analyzed by XPS at the Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA. A broad peak centered at 54.6 eV was present; whereas, the control nickel tube showed no feature. The binding energy (in vacuum) of H(n = 1/2) is 54.4 eV. Thus, the theoretical and measured binding energies for H(n = 1/2) are in excellent agreement. No excess energy or 54.6 eV feature were observed when sodium carbonate replaced potassium carbonate.

**7. Gernert, N., Shaubach, R. M., Mills, R., Good, W., "Nascent Hydrogen: An Energy Source," Final Report prepared by Thermacore, Inc., for the Aero Propulsion and Power Directorate, Wright Laboratory, Air Force Material Command (ASC), Wright-Patterson Air Force Base, Contract Number F33615-93-C-2326, May, (1994).**

In a report prepared for the Aero Propulsion and Power Directorate, Wright Laboratory, Air Force Material Command (ASC), Wright-Patterson Air Force Base, Thermacore reports, "anomalous heat was observed from a reaction of atomic hydrogen in contact with potassium carbonate on a nickel surface. The nickel surface consisted of 500 feet of 0.0625 inch diameter tubing wrapped in a coil. The coil was inserted into a pressure vessel containing a light water solution of potassium carbonate. The tubing and solution were heated to a steady state temperature of 249 °C using an I<sup>2</sup>R heater. Hydrogen at 1100 psig was applied to the inside of the tubing. After the application of hydrogen, a 32 °C increase in temperature of the cell was measured which corresponds to 25 watts of heat. Heat production under these conditions is predicted by the theory of Mills where a new species of hydrogen is produced that has a lower energy state than normal hydrogen. ESCA analysis, done independently by Zettlemoyer Center for

Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA, have found the predicted 55 eV signature of this new species of hydrogen."

**6. Wiesmann, H., Brookhaven National Laboratory, Department of Applied Science, Letter to Dr. Walter Polansky of the Department of Energy Regarding Excess Energy Verification at Brookhaven National Laboratory, October 16, 1991.**

Calorimetry of continuous electrolysis of aqueous potassium carbonate ( $K^+/K^+$  electrocatalytic couple) at a nickel cathode was performed in single cell dewar calorimetry cell by Noninski at Brookhaven National Laboratory. Dr. Weismann observed the experiment and reported the results to Dr. Walter Polansky of the U. S. Department of Energy. Dr. Weismann reports, "The claim is as follows. The temperature rise in the dewar is greater in the case of electrolysis as compared to using a resistor, even though the power dissipated is equal in both cases. According to Dr. Mills' theory, this apparent "excess power" is due to the fact that the electron in a hydrogen atom can "decay" to stable subinterger quantum levels. Dr. Noninski demonstrated this thermal effect at BNL." The observed rise in temperature for a given input power was twice as high comparing electrolysis versus heater power.

**5. Nesterov, S. B., Kryukov, A. P., Moscow Power Engineering Institute Affidavit, February, 26, 1993.**

The Moscow Power Engineering Institute experiments showed 0.75 watts of heat output with only 0.3 watts of total power input (power = VI) during the electrolysis of an aqueous potassium carbonate electrolyte with a nickel foil cathode and a platinized titanium anode. Excess power over the total input on the order of 0.45 watts was produced reliably and continuously over a period of three months. Evaluation of the electrolyte after three months of operation showed no significant change in its density or molar concentration. The cell was disassembled and inspected after over one month of operation at 0.1 amperes. This inspection showed no visible signs of a reaction between the electrodes and the electrolyte. The cell was re-assembled and operated

as before. Excess energy was produced for the three month duration of the experiment. Scintillation counter measurements showed no signs of radiation external to the cell.

**4. Miller, A., Simmons, G., Lehigh X-Ray Photoelectron Spectroscopy Report, Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University Bethlehem, PA, November 1993.**

Samples of the nickel cathodes of aqueous potassium carbonate electrolytic cells and aqueous sodium carbonate electrolytic cells were analyzed by XPS by Miller and Simmons of the Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA. A broad peak centered at 54.6 eV was present only in the cases of the potassium carbonate cells. The binding energy (in vacuum) of  $H(n = 1/2)$  is 54.4 eV. Thus, the theoretical and measured binding energies for  $H(n = 1/2)$  are in excellent agreement. Lehigh University has conducted an extensive investigation of the cathodes from heat producing as well as those from control cells. Miller concludes that "I was unable to find any other elements on the surface that cause the feature. The persistent appearance of a spectral feature near the predicted binding energy for many of the electrodes used with a K electrolyte is an encouraging piece of evidence for the existence of the reduced energy state hydrogen".

**3. Jacox, M. G., Watts, K. D., "INEL XPS Report", Idaho National Engineering Laboratory, EG&G Idaho, Inc., Idaho Falls, Idaho, 83415, November 1993.**

The Lehigh XPS results of a broad peak centered at 54.6 eV present only in the cases of the potassium carbonate cells [Miller, A., Simmons, G., Lehigh X-Ray Photoelectron Spectroscopy Report, Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA, November 1993] were confirmed at Idaho National Engineering Laboratory (INEL). Samples which demonstrated the feature as well as control electrodes were tested for the presence of trace amounts of impurities of the elements iron and lithium at a sensitivity level of greater than 1000 times that of XPS. TOF-SIMS (Time of Flight-Secondary Ion Mass Spectroscopy) and XPS analysis of the nickel surface was performed by Charles Evans & Associates, Sunnyvale, CA [Lee, Jang-Jung, Charles Evans & Associates Time-Of-Flight Secondary

Ion Mass Spectroscopy (TOF-SIMS) Surface Analysis Report, CE&A Number 40150, March 18, 1994]. The 54.6 eV feature was also observed by Charles Evans & Associates in the case of cathodes of potassium carbonate electrolytic cells [Craig, A., Y., Charles Evans & Associates XPS/ESCA Results, CE&A Number 44545, November 3, 1994]. Iron and lithium were the only remaining atoms which were in question by Lehigh University and INEL as the source of the 54.6 eV XPS peak. The Charles Evans TOF-SIMS results demonstrate that iron and lithium were not the source of this peak.

**2. Lee, Jang-Jung, Charles Evans & Associates Time-Of-Flight Secondary Ion Mass Spectroscopy (TOF-SIMS) Surface Analysis Report, CE&A Number 40150, March 18, 1994.**

The Lehigh XPS results of a broad peak centered at 54.6 eV present only in the cases of the potassium carbonate cells [Miller, A., Simmons, G., Lehigh X-Ray Photoelectron Spectroscopy Report, Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA, November 1993] were confirmed at Idaho National Engineering Laboratory (INEL) [Jacox, M. G., Watts, K. D., "INEL XPS Report", Idaho National Engineering Laboratory, EG&G Idaho, Inc., Idaho Falls, Idaho, 83415, November 1993]. Samples which demonstrated the feature as well as control electrodes were tested for the presence of trace amounts of impurities of the elements iron and lithium at a sensitivity level of greater than 1000 times that of XPS. TOF-SIMS (Time of Flight-Secondary Ion Mass Spectroscopy) and XPS analysis of the nickel surface was performed by Charles Evans & Associates, Sunnyvale, CA. The 54.6 eV feature was also observed by Charles Evans & Associates in the case of cathodes of potassium carbonate electrolytic cells [Jacox, M. G., Watts, K. D., "INEL XPS Report", Idaho National Engineering Laboratory, EG&G Idaho, Inc., Idaho Falls, Idaho, 83415, November 1993]. Iron and lithium were the only remaining atoms which were in question by Lehigh University and INEL as the source of the 54.6 eV XPS peak. The Charles Evans TOF-SIMS results demonstrate that iron and lithium were not the source of this peak.

**1. Craig, A., Y., Charles Evans & Associates XPS/ESCA Results, CE&A Number 44545, November 3, 1994.**

The Lehigh XPS results of a broad peak centered at 54.6 eV present only in the cases of the potassium carbonate cells [Miller, A., Simmons, G., Lehigh X-Ray Photoelectron Spectroscopy Report, Zettlemoyer Center for Surface Studies, Sinclair Laboratory, Lehigh University, Bethlehem, PA, November 1993] were confirmed at Idaho National Engineering Laboratory (INEL) [Jacox, M. G., Watts, K. D., "INEL XPS Report", Idaho National Engineering Laboratory, EG&G Idaho, Inc., Idaho Falls, Idaho, 83415, November 1993]. Samples which demonstrated the feature as well as control electrodes were tested for the presence of trace amounts of impurities of the elements iron and lithium at a sensitivity level of greater than 1000 times that of XPS. TOF-SIMS (Time of Flight-Secondary Ion Mass Spectroscopy) and XPS analysis of the nickel surface was performed by Charles Evans & Associates, Sunnyvale, CA [Lee, Jang-Jung, Charles Evans & Associates Time-Of-Flight Secondary Ion Mass Spectroscopy (TOF-SIMS) Surface Analysis Report, CE&A Number 40150, March 18, 1994]. The 54.6 eV feature was also observed by Charles Evans & Associates in the case of cathodes of potassium carbonate electrolytic cells. Iron and lithium were the only remaining atoms which were in question by Lehigh University and INEL as the source of the 54.6 eV XPS peak. The Charles Evans TOF-SIMS results demonstrate that iron and lithium were not the source of this peak.

Given Applicant's full compliance with the new standards imposed by Specialist McGinty during the February 11, 2003 Interview, which required independent validation of the experimental evidence of record, Applicant is entitled to have this evidence accepted as reliable and to have this and other BlackLight applications issue as patents.

**Examiner Langel's Reaffirmation of the Utility and Operability of Applicant's Novel Hydrogen Technology and His Subsequent Resignation From Examining BlackLight Cases "For Moral and Ethical Reasons"**

Pursuant to the representations and agreements made during the February 11 Interview (reprinted below), Applicant followed up by submitting much of the independently generated scientific evidence cited above in two pending BlackLight applications and arranging an Interview with Examiner Langel, who was assigned to

those cases and supposedly had full authority to issue them. [U.S. Serial Nos. 09/110,678 ('678 application) and 09/362,693 ('693 application).] The express purpose of the Interview, held on April 14, 2003, was to review those two applications on a claim-by-claim basis to ensure that the scientific data presented adequately supported the scope of the claims. Examiner Langel expressed once again his view that the claims of the two applications were adequately supported by the data and, therefore, those claims were allowable.

A detailed account of the discussions Applicant's counsel, Jeffrey Melcher and Jeffrey Simenauer, had with Examiner Langel during the April 14, 2003 Interview, and with Examiner Langel and his supervisor, SPE Stanley Silverman, during follow-up telephone Interviews were documented in Supplemental Responses filed in the '678 and '693 applications, comments from which are reproduced below. Based on the shocking revelations divulged during these discussions, Applicant must once again protest in the strongest terms possible the manner in which an anonymous group of PTO officials (*i.e.*, the "Secret Committee") has mishandled the examination of BlackLight's patent applications relating to Applicant's novel hydrogen technology.

Counsel was particularly distressed to learn that when Examiner Langel met with Supervisor Silverman to advocate allowing the '678 and '693 applications to issue as patents, his supervisor informed him that "allowance is not an option." Despite the Examiner's careful study of the overwhelming weight of the scientific data supporting allowance, his supervisor further instructed him to "make it appear as if you have authority [to allow the applications] and that you are in favor of full rejection."

Understandably, Examiner Langel felt uneasy having been asked to make representations on the record that were not true. He explained that, "for moral and ethical reasons," he had no choice but to allow himself to be removed from examining all assigned BlackLight applications. Although Supervisor Silverman admitted that the removal decision had been made "partially by [him] and partially by others," he would not reveal who those "others" were.

Applicant strongly objects to Examiner Langel's removal under these egregious circumstances and demands that the PTO reinstate him immediately and allow BlackLight's applications to issue. The Secret Committee is duty bound to honor the representations

and agreements made by Quality Assurance Specialist Douglas McGinty during the February 11, 2003 Interview, declaring that:

- (1) Examiner Langel and the other Examiners of record have "full authority" to review the scientific data supporting lower energy states of hydrogen generated and furnished by independent third parties and, based on that review, to issue patents as deemed appropriate;
- (2) Applicant should confer with the Examiners, either by telephone or in person, to review each assigned application on a claim-by-claim basis to ensure that the scientific data presented adequately supports the scope of the claims; and
- (3) for those claims determined to be adequately supported by the data, a patent will issue; for any claims deemed to be inadequately supported, Applicant reserves the right to continue seeking that broader claim coverage in subsequent proceedings. [See March 6, 2003 Response filed in the '678 application.]

It was precisely because of the many prior abuses that led to this short-lived "breakthrough" that U.S. Congressman David Wu sent his Senior Legislative Assistant, Ted Liu, to attend the February 11 Interview. Prior to the Interview, a senior PTO official alleged to Mr. Liu that there was no "Secret Committee." At the Interview, Mr. Liu witnessed not only Specialist McGinty's representation that Examiner Langel had the authority to allow BlackLight's applications, but the Examiner's unequivocal statement that the applications were, in fact, allowable and that he was prepared to issue Applicant his patents right then and there. [See *supra* and Attachment P]

Despite those representations, an anonymous group of individuals has now declared that allowance is not even an option in BlackLight's cases. Worse yet, this Secret Committee sought to leave the false impression on the record that Examiner Langel—and perhaps other Examiners of record—had the authority to allow BlackLight's applications, and that he favored the rejection of claims over allowance.

In view of this unfortunate incident, which is described in greater detail below, Applicant is entitled to a complete accounting of events leading to Examiner Langel's removal, including identification of all persons involved in making that decision.



### **Detailed Account of the April 14, 2003 Interview and Subsequent Discussions**

As stated above, the express purpose of the April 14, 2003 Interview was to review the scientific data generated and furnished by independent third parties identified in the March 6, 2003 Response that was filed in the '678 and '693 applications in support of the lower energy states of hydrogen and to ensure that the data adequately supported the scope of the claims to secure their allowance.

Applicant had no reason to suspect that this new approach, as agreed to during the prior February 11, 2003 Interview, was about to be completely scrapped. During the subsequent April 14, 2003 Interview, Examiner Langel once again reaffirmed his long-held opinion that the scientific data submitted by Applicant confirmed the operability of his novel hydrogen technology, thus warranting patent protection. The Examiner's comments made clear that, prior to the interview, he had extensively reviewed Applicant's data, as well as the summary statements characterizing that data, appearing in the prior Responses filed in the '678 and '693 applications. Based on that review, Examiner Langel expressed several times during the Interview his willingness to allow those cases. Those views were confirmed by the Examiner in his interview summary, which stated that "[t]he participants presented data establishing the existence of lower-energy hydrogen." [See April 14, 2003 Interview Summary Form filed in the '678 and '693 applications (Attachment F).]

Examiner Langel, however, refrained from indicating allowance of any specific claims for two stated reasons. First, a few items of submitted data summarized in the March 6 Response inexplicably could not be located in the PTO files. The Examiner wanted time to confirm the data had been made of record, as well as Applicant's description of its relevance. Second, despite Specialist McGinty's representation at the February 11 Interview that Examiner Langel had full authority to review the data and to issue claims in the two interviewed cases, the Examiner explained that he needed to advise him and Supervisor Silverman of his intention to do so.

Examiner Langel then recalled a recent visit to his office by Group Director Jacqueline Stone informing him—again, contrary to what Applicant was told at the February 11, 2003 Interview—that he did not have authority to issue Notices of Allowance, or to otherwise give indications of allowance, in any BlackLight applications.

Director Stone instructed Examiner Langel that he would need Specialist McGinty's permission before doing so.

Examiner Langel did, however, note that Supervisor Silverman and Specialist McGinty had agreed before the February 11 Interview to allow claims if Applicant could show that his submitted scientific data was generated by independent third parties. The Examiner reassured counsel that he would present to his superiors the scientific data discussed at the April 14 Interview with a recommendation of allowance consistent with his past views.

Applicant's counsel agreed that it made sense to allow time for Examiner Langel to discuss the case with his superiors and for counsel to resubmit the few missing items of scientific data, whereupon arrangement was made to continue with the personal Interview on the following day, April 15<sup>th</sup>. That morning, however, counsel received a distressing telephone message from Examiner Langel that the Interview had been canceled. The Examiner stated that Supervisor Silverman had removed him from the subject cases and that he was no longer assigned to any BlackLight applications.

Applicant's counsel immediately telephoned Examiner Langel for a further explanation of what had happened. The Examiner confirmed his removal following the meeting he had arranged with Supervisor Silverman to discuss the scientific data that had been the subject of the previous day's Interview and to advocate allowance of the claims in the two subject applications. Examiner Langel informed counsel that his supervisor refused to even look at the data and, in response to his recommendation of allowance, Supervisor Silverman told him "allowance is not an option." According to Examiner Langel he was then told: "Make it appear as if you have authority [to allow the applications] and that you are in favor of full rejection."

Examiner Langel explained that, regrettably, he had no choice but to resign from further examination of BlackLight's applications. According to the Examiner, Supervisor Silverman gave him the option of staying on, "but not really—I could not go on like this." He explained that "for moral and ethical reasons," he could no longer continue to examine his assigned cases.

Alarmed by this sudden turn of events, counsel called Supervisor Silverman the following day, April 16<sup>th</sup>, to protest Examiner Langel's removal and to seek his

reinstatement. Supervisor Silverman confirmed that Examiner Langel would no longer be examining Blacklight's patent applications and that all of its cases were in the process of being consolidated and transferred to a new Examiner.

Counsel kindly requested that Supervisor Silverman explain why those cases were being transferred and who made that decision. He initially refused to discuss the matter, saying only that, "I am not going to be put on the stand and cross examined on this." Upon further prodding, Supervisor Silverman volunteered that "the decision was made partially by me and partially by others." He refused, however, to be more specific when asked to identify the "others" involved in the decision, stating "I am not going to discuss that. You can say that it was *my* decision."

Counsel then informed Supervisor Silverman of Applicant's intention to file an objection to Examiner Langel's removal and to the consolidation and transfer of BlackLight's applications to a new Examiner. Counsel explained that Applicant had expended enormous amounts of time and money over a period of many years prosecuting BlackLight's patent applications before Examiner Langel and getting him up to speed on the claimed technology and the extensive scientific data confirming its operation. Counsel argued that it was unfair to remove Examiner Langel and transfer all of BlackLight's cases to a new Examiner just to begin the process all over again. Supervisor Silverman would hear none of it, again stating, "I'm not going to discuss it."

Applicant's counsel made one last attempt to learn the identity of the other PTO officials responsible for taking this drastic action and their reasons for doing so. Supervisor Silverman again refused this request for information, snapping at counsel, "You figure it out!" Counsel then asked the Supervisor whom they might talk to so they could "figure it out" as he had put it. Supervisor Silverman advised counsel, "Talk to whomever you want," but when asked whom specifically he had in mind, he again retorted, "I don't like to be cross-examined."<sup>115</sup>

At the end of the conversation, Supervisor Silverman attempted to justify the PTO's extreme actions by claiming that it was in the "best interest" to transfer the

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<sup>115</sup> Counsel has taken steps "to figure it out" and expressly reserves the right to further supplement the objections raised herein as additional facts come to light. (Attachment R)

applications. But, when asked by counsel whose best interest was being served by the transfer, he refused to answer. Supervisor Silverman, however, did offer the stunning revelation that Applicant's novel hydrogen technology was "beyond Examiner Langel's technical expertise" and that all of BlackLight's cases would be consolidated and transferred to another examiner with "more technical expertise." He would not elaborate on who this new, more highly qualified Examiner might be.<sup>116</sup>

Needless to say, at no time during the five years Applicant had been prosecuting his patent applications before Examiner Langel—who has over thirty years of Patent Office experience—did his technical expertise ever come into question. Indeed, throughout the lengthy prosecution of these cases, counsel has been impressed with the Examiner's in-depth knowledge of chemistry and physics, as well as other scientific principles, underlying Applicant's technology. That Supervisor Silverman would raise Examiner Langel's technical competence as an issue at such a late stage of that prosecution only heightens Applicant's suspicions as to the real motivation for removing Examiner Langel.

Immediately following the conversation with Supervisor Silverman, counsel telephoned Examiner Langel one last time to apprise him of the situation and to thank him for his many years of service in examining BlackLight's applications. Examiner Langel expressed regret over his removal from those cases and confirmed that he had "learned a lot about [BlackLight's] technology." The Examiner also expressed surprise that his expertise was now being called into question.

Examiner Langel shared counsel's exasperation over the situation. Counsel asked him if he knew of any other instances in which a PTO Examiner had been instructed to represent that he had authority to allow an application when, in fact, he had no such authority, and that he favored rejecting claims when he actually wanted to allow them. The Examiner's exact words were: "I've never seen anything like it."

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<sup>116</sup> All of BlackLight's applications have now been consolidated under the direction of a newly identified Examiner, Dr. Bernard Eng-Kie Souw, whose views have been adopted by the Committee in rejecting Applicant's cases in the name of four Examiners: Examiners Kalafut, Tsang-Foster, Wells, and Tanner. Applicant notes, however, that Dr. Souw is far less experienced in patent matters than his predecessor, Examiner Langel. Furthermore, as discussed in detail below, Dr. Souw's views are not only technically inaccurate, but are also tainted due to a genuine conflict of interest based on his involvement in questionable outside business activities while examining Applicant's cases.

Frankly, neither has Applicant's counsel and, in view of these unique circumstances, Applicant must once again strenuously object to the abusive treatment to which his applications have been subjected.

**The Secret Committee Has Demonstrated Extreme Bias In Its Handling of BlackLight's Patent Applications Due to Genuine Conflicts of Interest**

Following Examiner Langel's unfortunate resignation from examining BlackLight's applications, the Committee consolidated those cases under a new, supposedly more experienced Examiner. Consequently, the Committee's rejections of Applicant's claims in this and other pending BlackLight applications based on inoperability due to the alleged non-existence of lower-energy hydrogen now rely heavily, if not almost exclusively, on the views expressed by that new Examiner, Dr. Bernard Eng-Kie Souw. Indeed, Dr. Souw is known to have prepared on behalf of the Committee over one hundred pages of arguments, which in one form or another, have now found their way into all of BlackLight's cases in support of the Committee's rejections.

As explained in more detail below, Dr. Souw's involvement in shaping the Committee's views in this case raises serious questions regarding the biased nature of those views due to his genuine conflicts of interest. In fact, Dr. Souw's biased views have so tainted the present rejections that the Committee must withdraw those rejections and allow the pending claims to issue.

**The Committee's Refusal To Disclose the Details of Dr. Souw's Employment History Raises Serious Questions Of Whether It Is Capable Of Fairly Examining Applicant's Cases**

The Committee's appointment of Dr. Souw came at a critical juncture in the examination of Applicant's pending cases. As explained above, in April 2003, Examiner Langel, one of the two original examiners assigned to these cases, had resigned from his examining duties "for moral and ethical reasons." Examiner Langel's abrupt resignation came after being instructed to misrepresent that he favored denying Applicant his patents when the record showed he wanted to allow those patents to issue, and that he had authority to grant such allowance when, in fact, he was told that "allowance is not an option."

To justify Examiner Langel's resignation after the fact, the PTO informed Applicant that his cases were being transferred and consolidated under the direction of an Examiner with "more technical experience." A few short weeks later, Dr. Souw began making appearances in Applicant's cases even though he had only a few years of experience as an Associate Examiner, as compared to Primary Examiner Langel, who had over thirty years of PTO examining experience. [See Appendix attached to the Committee's May 7, 2003 Office Action issued in U.S. App'n Ser. No. 09/513,768 ('768 application).] Examiner Langel also demonstrated a far superior technical understanding of Applicant's technology judging by the far superior arguments found throughout Dr. Souw's Appendices.

Applicant was naturally suspicious of Dr. Souw's prominent membership on the Committee given the prosecution history of BlackLight's pending applications already discussed. As further detailed below, this new appointment prompted Applicant to raise initial questions regarding Dr. Souw's employment history after he first showed bias in examining these cases by citing his own technical papers against Applicant. Rather than answer those questions, the Committee stonewalled once again, defensively arguing that:

[T]he employment history of examiners, including those acting in a consulting role, is irrelevant to the examination thereof, except where there is a genuine conflict of interest. [See 4/14/04 Office Action in U.S. App'n Ser. No. 09/008,947 at p. 5.]

Dr. Souw has been similarly uncooperative, although he did provide some limited information regarding his employment history by citing to his background in microwave plasmas:

Since the cited Examiner's papers cannot possibly have been criticized by Applicant, citing his own publication(s) does not make the Examiner's view "biased", as alleged by Applicant. In the contrary, such technical papers provide a solid evidence that the Examiner is in possession of sufficient background for evaluating Applicant's claimed invention. In this regard, the Examiner can add a further evidence of strong background in microwave plasmas generated in a resonance cavity similar to those used by Applicant, not only in theory, but also hands-on in its design, construction and routine operation, as well as in its spectroscopy, both low and high resolutions [1]. [Souw Appendix at p. 4 attached to the March 29, 2004 Office Action filed in the '768 application.]

The reference [1] cited by the Examiner as evidence of his supposed "strong background in microwave plasmas" is an article published in March 1987: Souw, Eng-Kie, Plasma density measurement in an imperfect microwave cavity, J. Appl. Phys. 61 (5), 1 March 1987.<sup>117</sup>

The Committee's defensive remarks regarding the irrelevancy of Dr. Souw's employment history, when contrasted with the Examiner's own remarks extolling the relevancy of that history, are truly astounding. The Committee's statements are even more remarkable, however, when considered in the context of additional information that has come to Applicant's attention concerning Dr. Souw's engagement in questionable business activities that began before, and continued after, all of BlackLight's pending applications were consolidated and assigned to Dr. Souw.

This information came to light only after Applicant, unable to get straight answers from the Committee regarding Dr. Souw's background, undertook his own investigation into the Examiner's employment history. That investigation uncovered a much more recent 2003 article authored by Dr. Souw, in which he admits that he worked as the lead scientist for a consulting company that he co-founded, BMS Enterprise (BMS) in Herndon, Virginia, at the same time he worked for the PTO examining BlackLight's applications. Dr. Souw also admits in the article that his business activities for BMS includes work in at least two technical areas, which are identical to, and therefore compete with, those practiced by BlackLight.<sup>118</sup> Given that one of those technical areas is microwave plasmas, it is highly suspicious that the Committee and Dr. Souw withheld this highly relevant, up-to-date work experience in support of his supposedly "strong background in microwave plasmas," citing instead an outdated, 17-year-old article in

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<sup>117</sup> Ironically, Dr. Souw attempts to establish his credibility in evaluating Applicant's novel hydrogen technology by citing his peer-reviewed article published in the *Journal of Applied Physics*, yet argues that Applicant's article published in that very same journal does not establish similar credibility. In taking those contradictory positions, the Committee reveals yet another double standard that only reinforces its bias against Applicant.

<sup>118</sup> Incredibly, since the time Applicant first brought this information to the PTO's attention in his October 14, 2004 Response filed in U.S. Patent App'n Ser. No. 09/008,947, and subsequently in other pending cases, not only has the PTO failed to seriously address the issues raised, but it continues to cite and rely on Dr. Souw's biased arguments. These actions leave Applicant no choice but to seek other avenues for relief from this unfair treatment.

support. The reason the Committee and Dr. Souw withheld this important information is obvious: if correct—and Applicant has no reason to doubt this given that the source is Dr. Souw himself—there would appear to be multiple violations of the PTO's own ethics rules. At the very least, the ability of the Committee under the direction of Dr. Souw to fairly evaluate the merits of Applicant's novel hydrogen technology has once again been called into serious question.

The above-mentioned article was published in *Optical Engineering* on November 2, 2003. [Souw, Bernard Eng-Kie, Coherent telescope array with self-homodyne interferometric detection for optical communications, *Opt. Eng.* 42(1) 3139-3157 (November 2003) (Tab S).] As the author of that article, Dr. Souw's name prominently appears on first page (p. 3139), identifying his association with BMS as follows:

Bernard Eng-Kie Souw  
BMS Enterprise  
P.O. Box 5524  
Herndon, Virginia 20172-5524  
E-mail: souw1@juno.com

The last page of the article (p. 3157) is particularly informative as it summarizes Dr. Souw's technical background and work experience establishing his connection to BMS as its co-founder and lead scientist. Applicant reproduces the following relevant portions of that background summary, which notably describes BMS as providing consulting services in two main technical areas, microwave plasma devices and CVD diamond synthesis and applications, that are identical with those practiced by BlackLight:

In 1985, [Bernard Eng-Kie Souw] joined Brookhaven National Laboratory (BNL) in Long Island, New York as staff member in a Star Wars project. He was awarded a Department of Energy research grant in 1993 and became Principal Investigator in a research and development project on a novel, solar blind and fieldable alpha-beta-gamma radiation detector in collaboration with Northrop-Grumman and New Jersey Institute of Technology. **About the same time he cofounded BMS Enterprise, a multi-interdisciplinary consulting company providing services mainly in microwave plasma devices and CVD diamond synthesis and applications. He left BNL in 1997 and became a patent examiner with the US Patent and Trademark Office in Arlington, Virginia until**



**2000, when he joined ITT Industries in Reston, Virginia as a scientist and engineering specialist in optical communications. He left ITT in 2002 to dedicate more time as lead scientist with BMS Enterprise.**  
[Emphasis added.]

As the Committee is no doubt aware, Applicant's novel hydrogen technology has many potential commercial applications, including the aforementioned microwave plasma devices and CVD diamond synthesis. Indeed, Applicant presently has on file two copending applications directed to these specific art areas. [See U.S. App'n Ser. No. 10/469,913, filed March 7, 2002; and PCT/US/13412, filed May 1, 2002.] Applicant has serious concerns that these and other competitive technologies that BMS and BlackLight engage in may have affected, and will continue to affect, the manner in which the Committee has examined and rejected his applications.

This situation is particularly disturbing in light of PTO ethics rules that prohibit patent examiners from engaging in outside business activities that conflict with their assigned administrative duties. [See *Summary of Ethics Rules* for the U.S. Patent and Trademark Office published by the U.S. Department of Commerce, Office of the General Counsel, Ethics Division (2000) (Tab S)] As the introductory paragraph to these ethical rules makes clear, the issue involved here is one of public trust:

#### **PUBLIC SERVICE IS A PUBLIC TRUST**

As an employee of the U.S. Patent and Trademark Office you have been placed in a position of trust and are held to a high standard of ethical conduct. This handout contains a summary of the rules set forth in conflict of interest statutes and the *Standards of Ethical Conduct for Employees of the Executive Branch*. [Ethics Rules at p. 1 (Tab S)]

To hold examiners to this high standard of ethical conduct, the rules prohibit activities that would create a financial conflict of interest:

**Financial Conflicts of Interest.** You may not, as part of your official Government duties, participate in any matter that will have a direct and predictable effect on your personal financial interest, unless an exemption applies. This rule applies to matters involving specific parties in which you have a financial interest and to broad policy matters that affect many entities, including ones in which you have an interest (such as a policy affecting an entire industry sector if you have stock holdings in one of the

companies in the industry sector). [Ethics Rules at p. 2 (Tab S) (emphasis in original).]

Other PTO ethic rules govern outside employment activities:

**General Rule on Outside Activities.** You may not engage in outside employment or any other personal activity that conflicts with your Department position, including employment that requires disqualification from a significant part of your Government duties or an activity that creates an appearance of using your public office for private gain. You must disqualify yourself from participating in a matter as a Department employee which may affect the financial interests of an outside employer or in which an outside employer, or an organization in which you are an active participant, is a party or is representing a party. . . . [Ethics Rules at p. 5 (Tab S) (emphasis in original).]

These restrictions against financial conflicts of interest and outside employment activities are further amplified with specific reference to patent examiners in the following rules:

#### **Financial conflicts of Interest**

Conflicts of Interests regarding Patent Examiners If you are a patent examiner, you may not participate in the review of any patent if you have a financial interest in a company that may be affected by the issuance or denial of the patent (unless your interest is in publicly-traded stock valued at \$5,000 or less in all affected companies). . . . [Ethics Rules at p. 10 (Tab S)]

#### **Outside Employment and Activities**

Service with Non-Federal organizations If you serve as an officer or director of an outside organization, such as a professional association, you may not participate as a USPTO employee on any matter that is likely to affect the financial interests of the organization. This may preclude you from serving with organizations that are active in matters before your office. If it would benefit USPTO to have an official relationship with a private organization, you may be assigned as a liaison to the organization, in which case your service with the organization would be in an official capacity, rather than as an outside activity. However, you may not be assigned to service in an official capacity as an officer or director of a non-Federal organization (other than a standards-setting body). [Ethics Rules at p. 11-12 (Tab S) (emphasis in original).]

The applicability of these ethics rules to the present situation cannot be seriously disputed. Dr. Souw was employed as a PTO Examiner at the same time he admits to working as the lead scientist for BMS with an apparent ownership stake in the company, which has a competing interest with BlackLight. Indeed, records indicate that Dr. Souw was a PTO employee prior to the date *Optical Engineering* first received his BMS article on February 6, 2003, and throughout the time that paper was being revised and received on May 6, 2003, and ultimately published on November 2, 2003.<sup>119</sup>

The article's May 6, 2003 revision date is particularly significant. It was only one day later, on May 7, 2003, that the Committee began issuing rejections in BlackLight's pending cases based on Appendices authored by Dr. Souw, starting with the '768 application. Dr. Souw's genuine conflict of interest in working for BMS during his employ as a PTO examiner—and while rejecting a competitor's patent applications no less—should be obvious to any fair-minded person and, thus, requires no further discussion.<sup>120</sup>

This clear conflict of interest is especially troubling given the many other questionable activities that have occurred in the prosecution of BlackLight's applications as documented and described above, including:

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<sup>119</sup> See, for example, U.S. Patent No. 6,506,648, issued January 14, 2003, which identifies Bernard Souw as the Assistant Examiner. Based on established PTO procedures, Examiner Souw is believed to have been a PTO employee when the Notice of Allowance was issued in that case, well before January 2003.

<sup>120</sup> Interestingly, Dr. Souw mentions in his article that he co-founded BMS in 1993 while working for BNL and that he left BNL in 1997 to join the PTO, apparently while still operating BMS. According to the article, Dr. Souw then left the PTO in 2000 to join ITT Industries as a scientist/engineer in the optical communications field until 2002, when he left "to dedicate more time as lead scientist with BMS Enterprise." [Emphasis added.] Dr. Souw, however, notably fails to mention in the BMS article his apparent re-employment by the PTO, which failure, incidentally, does comply with at least one PTO ethics rule: "you may not use your Government title in connection with a non-Government activity." [[Ethics Rules at p. 7 (Tab S) (emphasis in original)]]

Also somewhat troubling is that Dr. Souw apparently continues to examine and issue applications in other art areas that overlap with his scientific work for BMS, including optical communications, which is the subject matter of his published article. [See, e.g., U.S. Patent No. 6,801,676, filed June 24, 2003 and issued October 5, 2004, on a "Method and apparatus for phase shifting an optical beam in an optical device with a buffer plug" (recognizing in the "Background of the Invention" section that "the need for fast and efficient optical-based technologies is increasing as Internet data traffic growth rate is overtaking voice traffic pushing the need for optical communications.")]

- (1) the withdrawal from issue of five allowed BlackLight applications under highly suspicious circumstances involving interference by Dr. Robert Park, spokesman for the American Physical Society (APS), a BlackLight competitor;
- (2) the admission by Dr. Park's APS colleague, Dr. Peter Zimmerman, that Dr. Park has a "Deep Throat" contact at the Patent Office who has provided him with information concerning BlackLight applications;
- (3) the rejection of Applicant's claims based on a non-peer reviewed article posted on an Internet bulletin board authored by Dr. Zimmerman, who has bragged that while working at the State Department his agency and the Patent Office "have fought back with success" against BlackLight;
- (4) Dr. Zimmerman's improper contact of scientific journals in an attempt to prevent Applicant from meeting the publication requirement imposed by the Committee before his experimental evidence would even be considered; and
- (5) Examiner Wayne Langel's untimely resignation from the examination of BlackLight's applications for "moral and ethical reasons" after being told to materially misrepresent the record and that "allowance is not an option" in these cases.

In view of this sordid prosecution history, Applicant is understandably outraged by the discovery that following Examiner Langel's unfortunate resignation, the Committee appointed Dr. Souw to continue carrying out its "allowance is not an option" policy while he represented a competing interest. Applicant has demanded several times that the PTO provide a complete accounting of the facts and circumstances surrounding prior questionable activities, including those summarized above. Applicant has made a similar demand for information in connection with this latest episode involving Dr. Souw's conflicted association with BMS Enterprise while assigned to examine and reject BlackLight's pending patent applications. Applicant now repeats

that demand for information here, including but not limited to a full disclosure of the facts and circumstances relating to:

- (1) Dr. Souw's appointment as an examiner assigned to review BlackLight's pending patent applications;
- (2) his outside business activities with BMS Enterprise, and with any other business ventures in which he has a financial interest;
- (3) his contact with any sources outside the PTO with regard to the subject matter disclosed in any of BlackLight's applications; and
- (4) his membership activities, or any other participation, in any professional organizations, including the APS.<sup>121</sup>

Unfortunately, like Applicant's many other information requests, this one too has been ignored by the Committee despite the serious implications of Dr. Souw's genuine conflict involving his outside business activities. The Committee's refusal to honor these requests, however, only raise further suspicions that there is more information that would only strengthen Applicant's case for a genuine conflict of interest.

Instead of being forthcoming with the true facts and circumstances surrounding that conflict, the Committee initially tried to obscure it by advancing irrelevant and factually inaccurate arguments that contradicted Dr. Souw's own admissions:

Applicant's remarks concerning examiner Souw, and the article (Attachment S) are noted. This article deals with a telescope array, and

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<sup>121</sup> This information is deemed relevant to the following additional PTO ethics rule:

**Appearances of Bias (non-Financial Conflicts of Interest)**

Participation in Professional Organizations If you are an active member of a professional organization, such as a member of a[n] association of attorneys or patent professionals, you will be barred from participating in USPTO on matters in which that organization is a party or is representing a party. If this will interfere with your USPTO duties, you should refrain from such activities or should seek advice from the Ethics Division. . . . [PTO Ethics Rules at p. 10 (Tab S)]

As explained in detail above, and in previous Responses, Applicant has good reason to believe that the APS, and perhaps other professional organizations, have become involved as active participants in these proceedings.

does not appear to show any conflict of interest between Dr. Souw's former employer, BMS Enterprise, and his consulting involvement with the present application. [See, e.g., December 21, 2004 Advisory Action filed in U.S. App'n Ser. No. 09/362,693 at p. 2 (emphasis added).]

The Committee's carefully crafted denial of Dr. Souw's obvious genuine conflict of interest only raised further suspicions by its failure to even address Applicant's basis for asserting the conflict. While the Committee claims to have noted Applicant's remarks regarding this issue, it is apparent from its initial brief response that, true to form, those remarks were wholly ignored.

The Committee's refusal to seriously address the conflict in this case is clear from its narrow focus on the subject matter of the Souw article. Although the Committee correctly notes that the article "deals with a telescope array," that fact is totally irrelevant and, thus, cannot possibly support the Committee's conclusion that the article "does not appear to show any conflict of interest." [Emphasis added.]

Applicant has never relied on the subject matter of Dr. Souw's article as a basis for establishing a conflict in the present application. Rather, as previously discussed, that showing is based upon Dr. Souw's admission in the background summary of the article that he co-founded BMS Enterprise and has continued to operate the company as its lead scientist.<sup>122</sup> In that capacity, he works in two main technical areas—microwave plasma devices and CVD diamond synthesis and applications—identical to those practiced by Applicant while also employed by the PTO to examine and reject Applicant's cases. The Committee's initial refusal to even acknowledge that aspect of Applicant's showing of a genuine conflict of interest in this case, much less discuss it, is telling and only confirms Applicant's showing that a conflict does indeed exist.

The Committee further confirms this conflict in its attempt to gloss over Dr. Souw's startling admission that he operates a business enterprise that competes with Applicant's business interests while examining his cases by claiming that the subject matter of the article, i.e., a telescope array, does not establish a conflict of interest

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<sup>122</sup> As footnoted above, Applicant's only reference to a conflict involving the subject matter of Dr. Souw's article, i.e. optical communications, revolves around his continued examination of other patent applicants' cases in that same art. This pattern of ignoring conflicts merely provides further support for, but does not form the basis of, Applicant's clear showing that Dr. Souw is also conflicted in this case based on his ongoing work for BMS, as disclosed in the article's background summary.

"between Dr. Souw's former employer, BMS Enterprise, and his consulting involvement with the present application." [Emphasis added.] Aside from being non-responsive, this argument is also factually inaccurate.

The Committee incorrectly refers to BMS as a "former employer," in contradiction to Dr. Souw's admissions that he co-founded BMS and, therefore, is presumably a principal owner of the company, and that he continued to operate the company after he was employed by the PTO as an Examiner. The Committee merely compounded its error based on the alleged "former employer" status of BMS with the unfounded conclusion that no conflict of interest exists between Dr. Souw's work for BMS as its lead scientist and his work for the PTO as the Examiner primarily responsible for examining and rejecting Applicant's cases. In drawing this erroneous conclusion, the Committee all but admits the obvious—that Dr. Souw's current employment with BMS does in fact create a genuine conflict of interest, which then taints the Committee's rejections in all of Applicant's cases.

Perhaps realizing the incoherence of its initial response regarding the issue of Dr. Souw's apparent conflict of interest, the Committee, in a subsequent response, drastically changed its position. Although the Committee no longer tries to mischaracterize BMS as a "former employer," astonishingly, it now argues that Dr. Souw's continued operation of that company while he examined and rejected Applicant's patent applications does not create a conflict:

Applicant also implies (page 108) that Dr. Bernard Souw, who has been consulted during the examination of his applications, is also involved in work "competitive" to this [sic] own, which would produce a conflict of interest. The evidence offered by applicant, an article written by Dr. Souw, deals with a telescope array, which is neither an alternative form of hydrogen nor a new previously unappreciated source of energy, and thus does not appear to be competitive with the present "hydrino" or any battery based thereon. While the biographical sketch at the end of the article mentions his involvement in consulting work having to do with microwave plasma devices and CVD diamond synthesis, this would not amount to competition with the present invention or the underlying hydrinos. Diamonds are a form of carbon, and thus are not in competition with hydrogen. Microwave plasma devices are not necessarily related to hydrogen, since they are a type of device or machine. [2/11/05 Office Action at page 4 filed in U.S. App'n Ser. No. 09/110,717.]

The Committee's latest arguments regarding Dr. Souw's conflicting business activities are no more convincing than those previously posited and, in fact, raise so many new issues, Applicant hardly knows where to begin. First, Applicant did not "imply" anything; rather, he simply quoted relevant portions of Dr. Souw's own article admitting to outside business activities that clearly conflict with technologies practiced by Applicant whose pending patent applications has examined and rejected. That alone is sufficient to establish a genuine conflict of interest that fatally taints the biased views of Dr. Souw, which have been universally adopted by the Committee.

Second, the Committee's comment regarding "the evidence offered by Applicant" is disturbing. It is not Applicant's responsibility to "offer" evidence that the Committee itself should have produced in the first place. Worse yet, the Committee continues to withhold additional evidence responsive to Applicant's reasonable request for background information relevant to Dr. Souw's employment history and any conflicts and biases he may have. If and when the Committee decides to cooperate in supplying the requested information, there no telling what additional genuine conflicts of interest will arise in this case based on "the evidence offered by Applicant."

Third, as previously discussed, the Committee's reliance on the subject matter of the article, i.e., a telescope array, is a "red herring" that has absolutely nothing to do with the conflict issues surrounding Dr. Souw's questionable business activities. Applicant has never once asserted that Dr. Souw's work in the area of telescope arrays creates a genuine conflict of interest in this case. For the Committee to raise this as an issue merely highlights the desperation of its latest arguments, further exposing the weakness of its position.

Fourth, the Committee uses strained reasoning in asserting that Dr. Souw's admission to his involvement in consulting work relating to microwave plasma devices and CVD diamond synthesis "would not amount to competition with the present invention or the underlying hydrinos." As explained above, and in other numerous responses, one direct application of the BlackLight's lower-energy hydrogen technology is CVD diamond synthesis, which subject is covered by claims in one of its pending patent applications. For the Committee to ignore this plain, simple fact and weakly argue instead that "[d]iamonds are a form of carbon, and thus are not in competition



with hydrogen" merely demonstrates its refusal to take the conflict issue seriously. Similarly, the Committee's excuse that "microwave plasma devices are not necessarily related to hydrogen, since they are a type of device or machine" hardly merits a response. Again, the formation of microwave plasmas is a direct application of BlackLight's lower-energy hydrogen technology as Dr. Souw himself has recognized, and is covered in its pending patent applications. Dr. Souw has recognized as much admitting that his work for BMS provides further evidence of his "strong background in microwave plasmas generated in a resonance cavity similar to those used by Applicant." [See, for example, Souw Appendix at p. 4 attached to the March 29, 2004 Office Action filed in U.S. App'n Ser. No 09/513,768.]

Fifth and finally, the PTO members of the Committee know better than anyone that direct competition between the Examiner and the Applicant whose case he is examining is not the proper standard used in determining the presence of a conflict of interest. Indeed, the PTO's own Ethics Rules, as discussed above, forbid an Examiner from engaging in outside employment activities that create even the appearance of impropriety:

**General Rule on Outside Activities.** You may not engage in outside employment or any other personal activity that conflicts with your Department position, including employment that requires disqualification from a significant part of your Government duties or an activity that creates an appearance of using your public office for private gain. . . . [Ethics Rules at p. 5 (Tab S) (emphasis in original).]

Incredibly, after initially withholding information about Dr. Souw's outside business interests, and then trying to pass him off as a former BMS employee, the Committee once again contradicts its own prior statements in a subsequent Office Action begrudgingly admitting that Dr. Souw, in fact, owns the company and, therefore, "may appear to have a conflict of interest." In making that admission, however, the Committee blatantly disregards the PTO's own Ethics Rules in contending that this appearance of impropriety does not prevent Dr. Souw from examining Applicant's patent cases based on the absurd argument that he does not work on fuel cells in direct competition with Applicant:

Applicant argues . . . that examiner Bernard Souw owns a company which provides consulting services in two technical areas, microwave plasma devices and CVD diamond synthesis. While an examiner with such outside employment may appear to have a conflict of interest, such a conflict can be avoided if he refrains from either working on applications dealing with these, or working on these things in his outside employment. The present application, however, is drawn to a fuel cell, which is outside those fields, and thus would not be in competition with any consultation therein. [Final Office Action dated July 18, 2005 issued in U.S. App'n Ser. No. 09/008,947.]

Like the Committee's previous attempts to cover up Dr. Souw's obvious conflict of interest, this one too must fail. Simply put, the presence or absence of direct competition is not the standard by which conflict of interest issues are to be judged. As noted above, the admitted appearance of a conflict is alone sufficient to disqualify Dr. Souw as an examiner in this case and exclude his biased arguments.

In any case, the Committee admits by its own arguments that Dr. Souw's work on microwave plasma devices and CVD diamond synthesis overlaps with Applicant's business interests and, therefore, denying Applicant his patents, including one in this case, works to Dr. Souw's economic benefit. Contrary to the Committee's misguided view of the rules on ethics, such a conflict is not avoided by Dr. Souw's alleged non-competition in the narrowly drawn field of fuel cells.

Applicant suspects that the Committee's latest self-serving statements are narrowly confined to avoid disclosing the full scope of Dr. Souw's outside business activities, which information Applicant has repeatedly requested for years without the courtesy of a response. Rather, the Committee incorrectly assumes, without basis, that Dr. Souw's outside business activities are limited to his work on microwave plasma devices and CVD diamond synthesis. Applicant knows for a fact, however, that these are not the only two technical fields in which Dr. Souw is engaged in, as he himself admits in the background section of the journal article unearthed by Applicant's counsel:

[Dr. Souw] cofounded BMS Enterprise, a multi-/interdisciplinary consulting company providing services mainly [i.e., not exclusively] in microwave plasma devices and CVD diamond synthesis and applications. [Souw, Bernard Eng-Kie, Coherent telescope array with self-homodyne interferometric detection for optical communications, Opt. Eng. 42(1) at

3157 (November 2003) (Tab S) (emphasis and explanatory note in brackets added).]

That statement makes clear that there are other technical fields Dr. Souw engages in through his work for BMS. The Committee's refusal to provide Applicant with this important relevant information only fuels suspicion that there are other conflicting technologies, either through BMS or perhaps other outside endeavors, that have not yet been revealed.

Applicant is particularly suspicious of the Committee's carefully worded statements regarding Dr. Souw's work in the fields of microwave plasmas and CVD diamond synthesis and that Applicant's '947 application is "drawn to a fuel cell, which is outside those fields, and thus would not be in competition with any consultation therein." That statement is not an affirmative declaration that Dr. Souw has refrained from working in other technical fields that may also be common to those applications he has examined or otherwise provided input.<sup>123</sup>

The Committee's tenuous arguments in this regard are also shot down by Dr. Souw himself through his own incriminating statements. For example, before counsel's independent investigation uncovered Dr. Souw's conflicting business activities for BMS, Dr. Souw proudly touted his supposed "strong background in microwave plasmas." According to Dr. Souw, this information was highly relevant to his qualifications for examining the subject matter of Applicant's pending cases:

In the contrary, such technical papers provide a solid evidence that the Examiner is in possession of sufficient background for evaluating Applicant's claimed invention. In this regard, the Examiner can add a further evidence of strong background in microwave plasmas generated in a resonance cavity similar to those used by Applicant, not only in theory, but also hands-on in its design, construction and routine operation, as well as in its spectroscopy, both low and high resolutions [1]. [Souw Appendix at p. 4 attached to the March 29, 2004 Office Action filed in the '768 application.]

By Dr. Souw's own admission, his work for BMS also provides further evidence of his "strong background in microwave plasmas generated in a resonance cavity similar to those

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<sup>123</sup> Of course, once a conflict of interest has been established in even one of Applicant's cases, that is a sufficient showing that Dr. Souw's bias has infected all of Applicant's cases in which his views appear.

used by Applicant” and, thus, clearly raises a genuine conflict of interest. For the Committee to limit discussion of the relevant subject matter of Applicant’s cases to “fuel cells,” or any other technological field supposedly outside the scope of Dr. Souw’s business activities—such as plasmas, for example—is simply nonsensical.

Of course, once the Committee comes clean with a full disclosure of all of Dr. Souw’s outside business activities, other conflicts may also emerge and Applicant anxiously awaits that information. In the meantime, the Committee only adds to the injustice perpetrated against Applicant by maintaining the rejections of record as it continues citing Dr. Souw’s biased views against Applicant.<sup>124</sup> Applicant once again strenuously protests this unfair treatment and demands that the rejections in the present application be withdrawn immediately so that this case can be allowed to finally issue.

**Dr. Souw’s Biased Views Adopted by the Committee  
are Further Demonstrated by Citation to His Own Work**

The genuine conflict of interest that surrounds the questionable employment history of Dr. Souw is not the only source of bias he brings to this case. Dr. Souw also demonstrates extreme bias by citing two of his own technical papers published in the journal *Physica* to support the rejection of Applicant’s claims on theoretical grounds. This procedural miscue is inherently unfair for two obvious reasons.

First, the Committee fails to show that the journals in which Dr. Souw’s technical papers appear are any more “scientifically qualified” with appropriate review process than the journals that published Applicant’s papers. Yet the Committee gives Dr. Souw’s papers the “credibility that peer-reviewed articles have,” while refusing to bestow that same credibility on Applicant’s peer-reviewed journal articles. [See, for example, page 5 of the Committee’s May 19, 2004 Office Action in U.S. App’n Ser. No. 09/362,693] The Committee’s reliance on Dr. Souw’s papers merely illustrates an obvious double standard and demonstrates once again its bias against Applicant in failing to fairly consider his experimental evidence published in prestigious journals as

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<sup>124</sup> Dr. Souw’s extreme bias is demonstrated by many of his outlandish statements adopted by the Committee, such as his comment equating Applicant’s sophisticated hydrogen technology with “crop circles”! [See May 12, 2005 Advisory Action in U.S. App’n Ser. No. 09/669,877.]

scientifically qualified, which evidence far outweighs the scant evidence produced by Dr. Souw. This double standard is but another example of the Committee's arbitrary and capricious handling of Applicant's cases.

Second, the Committee's reliance on the views of Dr. Souw based on citation of his own technical papers against Applicant is inherently unfair since Dr. Souw is no longer an impartial judge. How can the Examiner claim to be unbiased in response to arguments criticizing his own technical papers? The answer is obvious: he can't.

In any case, now that the Committee has relied upon Dr. Souw's own scientific research to support its rejections, Applicant is entitled to know from the Committee certain details of the Examiner's background, including a complete disclosure of his technical education and past work experiences. The Committee's steadfast refusal to disclose that relevant information only provides further basis for overturning its rejections.

In a previous Office Action, the Committee tried, but failed, to rationalize why Dr. Souw should be allowed to cite without scrutiny his own technical papers against Applicant:

Applicant note[s] the involvement of Examiner Bernard Souw in the examination of another of his applications, and that Examiner Souw had previously worked for Brookhaven National Labs. Two things are thus pointed out. First, examiners are allowed, and even encouraged, to consult other examiners on matters of science. Dr. Souw is the author of the attached Appendix. While originally written for Serial No. 09/513,768, the Appendix is considered relevant to the present application for reasons stated below. Second, the employment history of examiners, including those acting in a consulting role, is irrelevant to the examination thereof, except where there is a genuine conflict of interest. [See April 14, 2004 Office Action at p. 4 in U.S. App'n. Ser. No. 09/008,947]

The first point—that the PTO generally encourages consultation with other Examiners—is not even in dispute and is therefore irrelevant. The present objection to the Committee's consultation of Dr. Souw is his obvious bias in citing papers he authored, which requires that he critically analyze and respond to criticisms of his own work.

The PTO's second point—that the employment history of Examiners is only relevant when there is a “genuine conflict of interest”—is a backward standard that defies common sense.<sup>125</sup> As Applicant aptly demonstrated above, it was only after he was forced to conduct his own investigation into Dr. Souw's relevant employment history—because the Committee improperly withheld that information—that Applicant was then able to demonstrate the existence of a genuine conflict in this case. It would have been impossible to demonstrate that conflict had Applicant not known the Examiner's relevant employment history involving his ongoing ownership and operation of BMS Enterprise and, apparently, the Committee would have liked to keep it that way.

In any case, now that Applicant has satisfied the Committee's “genuine conflict of interest” requirement, the Committee is obligated under its own backward standard to disclose the complete nature and scope of Dr. Souw's employment history so that a full determination can be made regarding the existence of other such conflicts.

**Further Confirmation of the Secret Committee's “Allowance is Not an Option” Policy and Its Refusal to Grant Applicant a Fair and Expedient Hearing**

**Examiner Wayner Confirmed the Committee's Official Policy Not to Allow Applicant's Cases**

As discussed above, Examiner Langel initially advised Applicant that a Committee of PTO officials he could not identify was responsible for authoring the Office Actions he was instructed to sign as the named Examiner of record in the cases assigned to him. Examiner Kalafut later confirmed that he was also merely the named Examiner of record and that he too did not author the Office Actions issued by the Committee in his cases. Given that these two senior PTO employees, having over 50 years of experience between them, were being used as Examiners-in-name-only by this “Secret Committee,” Applicant found it odd that another named Examiner, William

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<sup>125</sup> Applicant disputes that a genuine conflict of interest is actually necessary to show bias—even the appearance of a conflict should be sufficient to taint the views expressed by Dr. Souw. This point is moot, however, since genuine conflicts of interest based on Dr. Souw's outside business activities have been shown, which conflicts have fatally infected Dr. Souw's biased views adopted by the Committee.

Wayner, would make the following statement in another BlackLight application to which he was assigned:

For the record this Examiner makes it clear that there is no committee in charge of this application, that all of the office actions in this case have been done by me alone an[d] that I have never been told that I could not allow this application. [See April 26, 2004 Office Action issued in U.S. App'n Ser. No. 09/181,180 ('180 application).]

Applicant's initial doubt regarding the veracity of that statement was confirmed in an initial telephone conversation held on October 5, 2004, between Applicant's counsel, Jeffrey A. Simenauer, and Mr. Wayner, following his retirement from the PTO as an Examiner, and in a follow-up telephone conversation held on October 25, 2004.

Sometime in mid-September, Mr. Wayner had called and left Mr. Simenauer, a former PTO colleague, a telephone message informing him of his retirement and his desire to secure patent search work to do in his spare time. Mr. Simenauer returned Mr. Wayner's call and spoke to him on October 5<sup>th</sup> about doing some possible work, after which the conversation turned to Mr. Wayner's involvement in the examination of the '180 application. The substance of that conversation was confirmed in an e-mail Mr. Simenauer sent to Mr. Wayner on October 15, 2004. [See Tab S]

During the October 5 phone conversation, Mr. Wayner was very candid in complimenting Dr. Mills for the way he had handled himself during the February 11, 2003 Interview, commenting that "Mills is one hell of a persuasive man" and that "he came across as very convincing" at the Interview. In his October 15 e-mail, Mr. Simenauer thanked Mr. Wayner for those comments, which he indicated had been forwarded to Dr. Mills.

Mr. Simenauer then told Mr. Wayner that, while he disagreed with the positions Mr. Wayner had expressed during the Interview, including his skepticism regarding the operability of Mills' invention, he still respected those views. Mr. Simenauer, however, made clear to Mr. Wayner that what really upset him were the questionable actions that the PTO has taken against BlackLight prejudicing its patent rights. In that regard, Mr. Simenauer recalled Examiner Langel's resignation from examining Applicant's cases "for moral and ethical reasons" due to instructions he had been given to misrepresent the record to promote the PTO's "allowance is not an option" policy. Specifically, Mr.

Simenauer reminded Mr. Wayner of how Examiner Langel was told to say that he was against allowing Dr. Mills' applications, when in fact he favored doing so, and that he had authority to issue Dr. Mills his patents, when he clearly had no such authority.

Mr. Wayner confirmed this official position of the Patent Office "not to allow [Dr. Mills'] cases" and admitted that he could not tell Mr. Simenauer this while he was still working at the PTO. As stated in his October 15 e-mail, Mr. Simenauer appreciated Mr. Wayner's honesty and understood why he had previously remained silent.

As further stated in his e-mail, Mr. Simenauer had first decided not to ask Mr. Wayner to go "on the record" with this information, given that Applicant already had a record of Examiner Langel's statements that the PTO had in place an "allowance is not an option" policy and that he was asked to misrepresent his authority to issue patents in BlackLight's cases. Mr. Simenauer mentioned, however, that a problem had arisen that had caused him to reconsider that decision. Mr. Simenauer explained that his review of Mr. Wayner's last Office Action in the '180 application had turned up the above-quoted statement that "I [Wayner] have never been told that I could not allow this application," which contradicted what Mr. Wayner had told Mr. Simenauer previously on the phone regarding his lack of authority to allow it.

In view of Examiner Langel's admission that he was told by senior PTO officials that he did not have authority to allow BlackLight's applications under any circumstances, but that he should give the false impression that he did have such authority, Mr. Simenauer expressed concern in his October 15 e-mail that the PTO might have put Mr. Wayner in a similar uncomfortable position when he stated that he had authority to allow the '180 application. Mr. Simenauer then informed Mr. Wayner that, as BlackLight's patent counsel, he was obligated to press the matter. Knowing Mr. Wayner to be "a man of utmost integrity," Mr. Simenauer further stated that he felt comfortable requesting "[his] assistance in simply uncovering the true facts regarding the PTO's policy decisions that have been made against BlackLight."

In response to Mr. Simenauer's e-mail, Mr. Wayner called him on October 25, 2004 and left a message, which call was then returned the same day by Mr. Simenauer and the undersigned co-counsel, Jeffrey S. Melcher. At no time during this subsequent telephone conversation did Mr. Wayner deny the substance of his earlier October 5<sup>th</sup>



conversation with Mr. Simenauer as reflected in the October 15<sup>th</sup> e-mail. Rather, Mr. Wayner started the conversation by stating, "You should know better. I don't want to get involved in this anymore." Mr. Wayner further stated that he did not want to talk any further about the subjects discussed in Mr. Simenauer's confirmation e-mail and that, in his words, "you will have to go by what's on the record," making clear to Applicant's counsel that he would not accept their request for assistance regarding the truth of his statements in the present Office Action.

Mr. Wayner also stated that while he wanted to continue his personal friendship with Mr. Simenauer, he also wanted "to stay out of the [BlackLight] case." Mr. Simenauer apologized for troubling him with this matter and informed Mr. Wayner that he may not be able to remain out of the BlackLight case against the PTO if it were to go to trial following an appeal to the PTO Board. Somewhat nervously, Wayner responded by stating that "it is a very dangerous situation" for him, and again made clear that he did not want to talk about it any further. Mr. Simenauer told Mr. Wayner that he understood and sympathized with his situation and that he did not want to put him in the uncomfortable position of having to say anything more on the subject.

Mr. Wayner then stated that he had changed his mind about seeking search work from Mr. Simenauer as he had initially requested since, in his words, "I don't want it to look like a *quid pro quo*." Again, Mr. Simenauer expressed his understanding of the situation Mr. Wayner found himself in and that ended the conversation.

In light of these unfortunate developments, Applicant must demand that the PTO Committee cease and desist from any further attempts to cloud the administrative record in his cases so as to make it appear that the "Examiners-in-name-only" are solely responsible for its actions. As with the situation involving instructions that led to Examiner Langel's resignation "for moral and ethical reasons," Applicant further demands that the Committee provide a complete account of the facts and circumstances that led to the questionable statements appearing in the Office Action signed by Examiner Wayner in the '180 application prior to his retirement.

**Examiner Tsang-Foster Has Confirmed the Committee's  
Refusal to Fairly Evaluate Applicant's Scientific Evidence**

The Committee's "allowance is not an option" policy has been further advanced by another Examiner-in-name-only, Susy N. Tsang-Foster. In those cases in which her name appears, Examiner Tsang-Foster basically admits to the Committee's continued refusal to grant Applicant a fair hearing on the mountain of scientific evidence, submitted at its request, proving the existence of lower energy states of hydrogen. [See, for example, the May 12, 2005 Advisory Action issued in U.S. App'n Ser. No. 09/669,877.]<sup>126</sup>

With now over 60 peer-reviewed articles published in respected scientific journals—and the list keeps growing—Applicant has achieved acceptance in the scientific community, which was improperly required by the Committee as a condition for patentability in this case. Rather than fully and fairly evaluate Applicant's compelling experimental evidence, the Committee now takes the extreme position that all of this evidence "detract[s] from the central issue that the hydrino does not theoretically exist." [See May 12, 2005 Advisory Action in U.S. App'n Ser. No. 09/669,877 at page 2 (emphasis added).] Out of the multitude of baseless arguments contrived by the Committee, this one truly stands out as perhaps the most outrageous.

Applicant has spent enormous amounts of effort and money complying with the PTO's arbitrary requirement that he publicly disclose his confidential data in peer-reviewed publications to prove the existence of lower-energy hydrogen. Now, incredibly, Applicant is being told that those efforts have been for naught since, according to the Committee, "all of applicant's data cannot prove what is not theoretically possible." [See May 12, 2005 Advisory Action in U.S. App'n Ser. No. 09/669,877 at page 2.] This statement is not only grossly erroneous, but it also contradicts the Committee's own prior statements. Indeed, in previous Office Actions,

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<sup>126</sup> The Committee created another procedural morass in that case when it issued the May 12, 2005 Advisory Action, which required Applicant's response to forty-four pages of new arguments and twenty-one newly cited references. It was bad enough that the Committee included these voluminous new arguments in an Advisory Action without extending Applicant the courtesy of withdrawing the finality of the April 22, 2004 Office Action and establishing a new time period for him to respond. The Committee only made the situation more onerous by mailing its Advisory Action on May 12, 2005, almost seven months after Applicant had responded to that Final Office Action on October 22, 2004, leaving Applicant less than ten days to respond.

Applicant attempted to correct this latest abuse of PTO procedures—effectively denying him a fair hearing—by requesting that a new time period be set. That request was initially ignored and then later denied without a satisfactory explanation.

the Committee has responded to Applicant's criticism by vehemently denying that it was taking the position that the existence of lower-energy hydrogen was impossible. For instance, Committee-member Souw tried to claim:

Contrary to Applicant's allegation on pg. 13, 1<sup>st</sup> full paragraph, lines 2-4, the PTO's view is not at all that the existence of lower-energy hydrogen were impossible, but instead, that (a) Applicant's invention is not supported by any experimental fact or evidence, and (b) the underlying theory (i.e., GUT/CQM) fails to support the invention, because it contains too many flaws. [Souw Appendix at p. 3 attached to the Committee's Final Office Action mailed August 24, 2004 in Applicant's U.S. Ser. No. 08/467,051 (emphasis added).]

Such inconsistent positions permeate all of the Committee's Office Actions and provide further grounds for overturning the pending rejections.

As Applicant has consistently argued, the only way to settle the theoretical argument on whether lower-energy hydrogen actually exists is to properly evaluate the real-world evidence that Applicant and independent third parties have generated. For the Committee to now assert that this real-world evidence "detract[s] from the central issue that the hydrino does not theoretically exist" turns science on its head and is an embarrassment to a government agency charged with "promot[ing] the Progress of Science and useful Arts." [See U.S. Constitution, Art. I, Sect. 8, Clause 8.]

#### **Demand for Information and Redress**

Applicant believes that the totality of events documented above are highly relevant to the PTO's examination of all of BlackLight's patent applications and accurately describe the detrimental effects that examination has had on Applicant's patent rights. These events further demonstrate the PTO's failure to provide adequate safeguards to the interests of Applicant, including fair and expeditious examination, as contemplated by the Federal Circuit in its June 28, 2002 Decision. Applicant therefore respectfully demands that the PTO provide certain information and redress, including:

- 1) identification of all Examiners or other PTO personnel who were consulted, or otherwise provided input, in the examination of BlackLight's applications;

- 2) identification of all other persons from outside the PTO who were consulted, or otherwise provided input, in the examination of BlackLight's applications;
- 3) identification of all PTO officials responsible for withdrawing BlackLight's five allowed applications from issuance and a complete disclosure of the facts and circumstances surrounding that withdrawal action;
- 4) identification of all outside sources of information who may have precipitated, or otherwise contributed to, the PTO withdrawing BlackLight's five allowed applications from issuance and a complete disclosure of the facts and circumstances surrounding those actions;
- 5) a complete disclosure of the facts and circumstances surrounding the removal of Examiner Langel from examining BlackLight's applications and the transfer those cases to a new Examiner, including, but not limited to, identification of all persons involved in those actions;
- 6) the information sought above in connection with the questionable statements made by Examiner Wayner in the '180 application;
- 7) the information sought above in connection with Dr. Souw's conflict of interest in owning and operating BMS Enterprise while assigned by the PTO to examine and reject BlackLight's pending patent applications;
- 8) the immediate removal of Dr. Souw, and other members of the Secret Committee, as Examiners in all pending BlackLight applications, and the reinstatement of Examiner Langel to his position as the Examiner of record in those cases to which he had been previously assigned;
- 9) the examination and issuance of all allowable BlackLight applications in accordance with the above-mentioned representations and agreements made at the February 11, 2003 Interview; and
- 10) as a matter of equity, the immediate issuance, without further examination, of all five of BlackLight's withdrawn patent applications due to the PTO's failure to provide the safeguards to the interests of Applicant, including fair and expeditious further examination, as contemplated by the Federal Circuit in its June 28, 2002 Decision.

#### **Response to Specific Arguments Presented in the Final Office Action**

Applicant reached agreements with the PTO during the February 11, 2003 Interview as to how it would conduct s itexamination of BlackLight's applications

following the tumultuous the present Action, now defaults on those agreements, whereby examination prosecution history of these cases. The Secret Committee, in its subsequent Office Actions, including in this case reverts back to ignoring most of Applicant's scientific evidence on baseless theoretical grounds and applying improper patent standards consistent with its "allowance is not an option" policy. Despite the unfairness of these actions, Applicant will not be deterred from seeking the patent rights to which he is entitled.

With that said, Applicant now turns to the Committee's latest arguments in the present Action, which primarily rely on the biased views of its newly appointed Examiner, Dr. Bernard Eng-Kie Souw, as expressed in his attached Appendix. Applicant rebuts each and every one of those arguments below and explains why they totally lack any merit. As previously discussed, the Committee's adoption of Dr. Souw's views to reject the claims in this case is also misguided due to his genuine conflict of interest in working as the lead scientist for a competing company while examining Applicant's cases and in citing his own technical papers against Applicant.

For these many reasons, the Committee's biased rejections are simply not credible and cannot stand up to Applicant's overwhelming experimental evidence of lower-energy hydrogen, which the Committee has either misconstrued or ignored altogether. Applicant therefore demands immediate allowance of all claims in this application and his other pending cases.

Applicant is once again disappointed to learn that the Committee has turned its back on an agreed upon standard, this time involving its self-imposed requirement that Applicant publish his experimental data supporting the existence of lower-energy hydrogen in peer-reviewed scientific journals. Incredibly, the Committee, on highly questionable grounds, summarily dismisses the entirety of that data. Applicant protests these arbitrary actions in the strongest terms possible and requests that the Committee reconsider its tenuous position.

To fully comprehend the unfairness of the Committee's dismissal of Applicant's scientific data, it should first be noted that it was the Committee that required Applicant, over his strenuous objections, to publish that data in peer-reviewed scientific journals. This requirement stemmed from an Interview held on February 21, 2001, during which

Examiner Vasudevan Jagannathan refused to take seriously the data presented at the Interview because it had not been subjected to the peer-review process required by most scientific journals prior to publication. For instance, as discussed above, Examiner Jagannathan mischaracterized Applicant's highly reliable spectroscopic data as nothing more than a "bunch of squiggly lines."

Despite the fact that the Committee has never cited any authority to support its publication requirement, Applicant expended considerable effort—not to mention millions of research dollars—complying with it. Yet, now that Applicant has published his experimental data in over 60 technical papers appearing in a number of respected scientific journals, with another 50-plus papers soon to follow, Applicant is advised that those efforts were for naught. Applicant is appalled that the Committee has categorized his papers based contrived excuses for ignoring their contents.

### **Category (1)**

The Committee incorrectly contends on page 2 of the Final Office Action that the articles identified as Reference Nos. 6, 10, 21, 70-86 and 92 "have not been peer reviewed, or published, but only submitted."<sup>127</sup> Based on that mistaken belief, the Committee concludes that those articles "do not (yet) have the credibility that peer reviewed articles have." [See page 2 of Final Office Action.]

Applicant finds somewhat amusing Dr. Souw's statement in his Appendix that "[b]ecause of their fundamental flaws, [these articles] are not likely to pass the peer review process." [See page 2 of Souw Appendix .] Given that many of these and other cited articles have in fact passed the peer review process and, therefore, do "have the credibility that peer reviewed articles have," this application is in condition for allowance according to the Committee's own strained standards.

### **Category (2)**

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<sup>127</sup> The Committee should also recognize that the current, complete list of Applicant's peer-reviewed articles includes Reference Nos. 34, 37-38, 40-43, 45-52, 54, 56-61, 63, 67, 69, 77, 81, 90, and 101. Applicant expects many more of his submitted journal articles to also complete the peer-review process and be published despite efforts by Dr. Zimmerman to prevent such publication.

The Committee states on page 3 of the Final Office Action that "[t]hey recite only theory behind applicant's invention, and while referring to other articles (mostly by applicant), do not contain data themselves. To this category belong attachments 4, 5, 23, 92, 93 and 96." This simply is not true. As discussed above and shown below, articles 5, 23, 92 and 93 disclose experimental evidence, which is the Committee improperly ignores:

4.) the identification of transitions of atomic hydrogen to lower energy levels corresponding to lower-energy hydrogen atoms in the extreme ultraviolet emission spectrum from interstellar medium and the sun [1, 5, 17, 28-29],

47.) the observation of anomalous plasmas formed with  $Sr$  and  $Ar^+$  catalysts at 1% of the theoretical or prior known voltage requirement with a light output per unit power input up to 8600 times that of the control standard light source [11, 16, 20, 23, 52, 72],

63.) the observation of energy balances of helium-hydrogen microwave plasmas of over 100 times the combustion of hydrogen and power densities greater than  $10 \text{ W/cm}^3$  measured by water bath calorimetry [34-36, 50, 63, 71, 73, 76-78, 84, 92, 93, 101],

68.) the isolation of novel hydrogen compounds as products of the reaction of atomic hydrogen with atoms and ions which formed an anomalous plasma as reported in the EUV studies [6-10, 19, 25, 38, 41, 44-45, 60-62, 75, 81, 87, 90, 92, 93, 100, 101],

75.) the identification of novel hydride compounds by a number of analytical methods such as (i) time of flight secondary ion mass spectroscopy which showed a dominant hydride ion in the negative ion spectrum, (ii) X-ray photoelectron spectroscopy which showed novel hydride peaks and significant shifts of the core levels of the primary elements bound to the novel hydride ions, (iii)  $^1H$  nuclear magnetic resonance spectroscopy (NMR) which showed extraordinary upfield chemical shifts compared to the NMR of the corresponding ordinary hydrides, and (iv) thermal decomposition with analysis by gas chromatography, and mass spectroscopy which identified the compounds as hydrides [6-10, 19, 25, 38, 41, 44-45, 60-62, 75, 81, 87, 90, 92, 93, 100], and

81.) the isolation of fraction-principal-quantum-level molecular hydrogen  $H_2(1/p)$  gas by liquefaction using an ultrahigh-vacuum, liquid nitrogen cryotrap, and the observations of novel peaks by cryogenic gas chromatography, a higher ionization energy than  $H_2$  by mass spectroscopy, a substantial change in the EUV emission spectrum with deuterium substitution in a region where no hydrogen emission has ever been observed, and upfield shifted NMR peaks at 0.21, 2.18 and 3.47 ppm compared to that of  $H_2$  at 4.63 ppm [75, 87, 90, 92, 93, 94, 101].

The description in papers 4 and 96 must be considered by the Committee and cannot simply be ignored.

### Category (3)

On page 3 of the final Office Action, the Committee argues that Applicant's papers "do not deal with the 'hydrino', but other subject matter, such as electrons in superfluid helium, and thus, even if valid, do not pertain to the present invention. To this category belong attachments 9, 17, 24, 59-61 and 95."

This is simply untrue. Applicant submits that articles 9, 17, 24, 59-61 and 95 in fact do pertain to the present invention and confirm a novel reaction of atomic hydrogen which produces hydrogen in fractional quantum states (hydrino) that are at lower energies than the traditional "ground" ( $n = 1$ ) state, a chemically generated or assisted plasma (rt-plasma), and produces novel hydride compounds as detailed in the document "Lower-Energy Hydrogen Experimental Data". Power conversion applications are also supported. Exemplary results include:

1.) the observation of intense extreme ultraviolet (EUV) emission at low temperatures (e.g.  $\approx 10^3 K$ ) from atomic hydrogen and only those atomized elements or gaseous ions which provide a net enthalpy of reaction of approximately  $m \cdot 27.2 eV$  via the ionization of  $t$  electrons to a continuum energy level where  $t$  and  $m$  are each an integer (e.g.  $K$  and  $Cs$  atoms and  $Rb^+$  and  $Sr^+$  ions ionize at integer multiples of the potential energy of atomic hydrogen and caused emission; whereas, the chemically similar atoms,  $Na$ ,  $Mg$ , and  $Ba$ , do not ionize at integer multiples of the potential energy of atomic hydrogen and caused no emission) [11-13, 15-16, 20, 24, 27, 32, 39, 42, 46-47, 51-52, 54-55, 57, 72, 81, 89, 91-93],



8.) the recent analysis of mobility and spectroscopy data of individual electrons in liquid helium which shows direct experimental confirmation that electrons may have fractional principal quantum energy levels [17, 53],

29.) the observation of stationary inverted H Balmer and Lyman populations from a low pressure water-vapor microwave discharge plasma with an overpopulation sufficient for lasing at wavelengths over a wide range from micron to blue wherein molecular oxygen served as the catalyst as supported by  $O^{2+}$  emission and H Balmer line broadening of 55 eV compared to 1 eV for hydrogen alone [59, 65-66, 68, 74, 83, 85],

32.) the observation of stimulation of the stationary inverted H Balmer population from a low pressure water-vapor microwave discharge plasma by back illumination with an infrared source that showed depopulation of the  $n = 5$  state [59, 65, 68, 85],

33.) the observation of stationary inverted H Balmer and Lyman populations from a low pressure water-vapor microwave discharge plasma with an overpopulation sufficient for lasing was observed for Evenson microwave plasmas, but not for RF or discharge plasmas [59, 65-66, 68, 73, 83, 85],

35.) the observation of stationary inverted H Balmer and Lyman populations from a low pressure water-vapor microwave discharge plasma with an overpopulation sufficient for lasing that was dependent on the pressure of the Evenson microwave plasma [59, 68, 73, 83, 85],

37.) the observation that the requirement for the natural hydrogen-oxygen stoichiometry of the Evenson water plasma was stringent in that a deviation by over 2% excess of either gas caused a reversal of the H inversion in water vapor plasmas [59, 68, 83, 85],

50.) the observation that microwave helium-hydrogen and argon-hydrogen plasmas having catalyst  $Ar^+$  or  $He^+$  showed extraordinary Balmer  $\alpha$  line broadening due to hydrogen catalysis corresponding to an average hydrogen atom temperature of 110-130 eV and 180-210 eV, respectively; whereas, plasmas of pure hydrogen, neon-hydrogen, krypton-hydrogen, and xenon-hydrogen showed no excessive broadening corresponding to an average hydrogen atom temperature of  $\approx 3$  eV [33-37, 43, 49, 60, 63-64, 69, 71, 73-74, 82, 84, 88],

72.) the identification of a novel highly stable surface coating  $SiH(1/p)$  by time of flight secondary ion mass spectroscopy that showed  $SiH^+$  in the positive spectrum and  $H^-$  dominant in the negative spectrum and by X-ray photoelectron spectroscopy which showed that the  $H$  content of the  $SiH$  coatings was hydride ions,  $H^-(1/4)$ ,  $H^-(1/9)$ , and  $H^-(1/11)$  corresponding to peaks at 11, 43, and 55 eV, respectively, and showed that the surface was remarkably stable to air [45, 61, 100],

73.) the isolation of novel inorganic hydride compounds such as  $KHKHCO_3$  and  $KH$  following each of the electrolysis and plasma electrolysis of a  $K_2CO_3$  electrolyte which comprised high binding energy hydride ions that were stable in water with their identification by methods such as (i) ToF-SIMS on  $KHKHCO_3$  which showed inorganic hydride clusters  $K[KHKHCO_3]^+$  and a negative ToF-SIMS dominated by hydride ion, (ii) X-ray photoelectron spectroscopy which showed novel peaks corresponding to high binding energy hydride ions, and (iii)  $^1H$  nuclear magnetic resonance spectroscopy which showed upfield shifted peaks corresponding to more diamagnetic, high-binding-energy hydride ions [6-7, 9, 38, 41],

Article 80 invalidates the argument that lower energy states are not theoretically possible according to quantum mechanics. The abstract follows:

Recently published data showing that the Rydberg series extends to lower states in a catalytic plasma reaction [R. L. Mills, P. Ray, "Extreme Ultraviolet Spectroscopy of Helium-Hydrogen Plasma", J. Phys. D, Applied Physics, Vol. 36, (2003), pp. 1535-1542] has implication for the theoretical basis of the stability of

the hydrogen atom. The hydrogen atom is the only real problem for which the Schrödinger equation can be solved without approximations; however, it only provides three quantum numbers—not four, and inescapable disagreements between observation and predictions arise from the later postulated Dirac equation as well as the Schrödinger equation. Furthermore, unlike physical laws such as Maxwell's equations, it is always disconcerting to those that study quantum mechanics (QM) that the particle-wave equation and the intrinsic Heisenberg Uncertainty Principle (HUP) must be accepted without any underlying physical basis for fundamental observables such as the stability of the hydrogen atom in the first place. In this instance, a circular argument regarding definitions for parameters in the wave equation solutions and the Rydberg series of spectral lines replaces a first-principles-based prediction of those lines. It is shown that the quantum theories of Bohr, Schrodinger, and Dirac provide no intrinsic stability of the hydrogen atom based on physics. An old argument from Feynman based on the HUP is shown to be internally inconsistent and fatally flawed. This argument further brings to light the many inconsistencies and shortcomings of QM and the intrinsic HUP that have not been reconciled from the days of their inception. The issue of stability to radiation needs to be resolved, and the solution may eliminate some of the mysteries and intrinsic problems of QM.

81.) the isolation of fraction-principal-quantum-level molecular hydrogen  $H_2(1/p)$  gas by liquefaction using an ultrahigh-vacuum, liquid nitrogen cryotrap, and the observations of novel peaks by cryogenic gas chromatography, a higher ionization energy than  $H_2$  by mass spectroscopy, a substantial change in the EUV emission spectrum with deuterium substitution in a region where no hydrogen emission has ever been observed, and upfield shifted NMR peaks at 0.21, 2.18 and 3.47 ppm compared to that of  $H_2$  at 4.63 ppm [75, 87, 90, 92, 93, 94, 101]. Thus, references 9, 17, 24, 59-61 and 95 do in fact support the lower energy states of hydrogen.

#### **Category (4)**

On pages 3-4 of the Final Office Action, the Committee incorrectly argues that Applicant's papers "contain data which cannot be accounted for by applicant's theory. ... To this category belong attachments 3, 81-84 and 89."

Applicant respectfully submits that the Committee has misstated his theory and has failed to recognize that the experimental  $q$  values measured accurately match those predicted by his theory. The Committee miscalculates the energy levels by failing to take into account the energy being transferred to the catalyst in an amount of  $m \times 27$  eV. If the catalyst enthalpy is properly considered, the Committee will arrive at the correct equation in which the spectral lines have a relationship of  $q \times 13.6$  eV. The assignments for the lines and correct calculations are provided in Table 1 of Reference No. 28 and Table 1 of Reference No. 33, discussed below. See also the present application, which lists the calculated energy levels (binding energy) and wavelength for each level of  $n=1/2$  to  $n=1/16$ . These equations are very basic to the understanding of Applicant's invention and have been recited in his applications for well over a decade.

Applicant once again points out that each catalyst utilized will provide a different distribution of lower-energy hydrogen states and consequently different emissions of  $q$ . In other words, each different catalyst may not provide all possible lower-energy hydrogen states and emissions  $q$  when reacted with hydrogen atoms. Nor is there any requirement in Applicant's theory or claimed invention that each catalyst provide all possible lower-energy states and possible emissions of  $q$  when reacted with hydrogen. For example, in the following two papers, the lower-energy hydrogen distribution for the helium catalyst are provided in Table 1:

33. R. L. Mills, P. Ray, B. Dhandapani, M. Nansteel, X. Chen, J. He, "New Power Source from Fractional Quantum Energy Levels of Atomic Hydrogen that Surpasses Internal Combustion", J Mol. Struct., Vol. 643, No. 1-3, (2002), pp. 43-54.
28. R. Mills, P. Ray, "Spectral Emission of Fractional Quantum Energy Levels of Atomic Hydrogen from a Helium-Hydrogen Plasma and the Implications for Dark Matter", Int. J. Hydrogen Energy, (2002), Vol. 27, No. 3, pp. 301-322.

From 67. R. L. Mills, P. Ray, "Extreme Ultraviolet Spectroscopy of Helium-Hydrogen Plasma", J. Phys. D, Applied Physics, Vol. 36, (2003), pp. 1535-1542:

It is well known that empirically the excited energy states of atomic hydrogen are given by Rydberg equation (Eq. (2a) for  $n > 1$  in Eq. (2b)).

$$E_n = -\frac{e^2}{n^2 8\pi\epsilon_0 a_H} = -\frac{13.598 \text{ eV}}{n^2} \quad (2a)$$

$$n = 1, 2, 3, \dots \quad (2b)$$

The  $n = 1$  state is the "ground" state for "pure" photon transitions (i.e. the  $n = 1$  state can absorb a photon and go to an excited electronic state, but it cannot release a photon and go to a lower-energy electronic state). However, an electron transition from the ground state to a lower-energy state may be possible by a resonant nonradiative energy transfer such as multipole coupling or a resonant collision mechanism. Processes such as hydrogen molecular bond formation that occur without photons and that require collisions are common. Also, some commercial phosphors are based on resonant nonradiative energy transfer involving multipole coupling.

We propose that atomic hydrogen may undergo a catalytic reaction with certain atoms and ions such as  $He^+$  which singly or multiply ionize at integer multiples of the potential energy of atomic hydrogen,  $m \cdot 27.2 \text{ eV}$  wherein  $m$  is an integer. The theory was given previously. The reaction involves a nonradiative energy transfer to form a hydrogen atom that is lower in energy than unreacted atomic hydrogen that corresponds to a fractional principal quantum number. That is

$$n = \frac{1}{2}, \frac{1}{3}, \frac{1}{4}, \dots, \frac{1}{p}; \quad p \text{ is an integer; } p \leq 137 \quad (2c)$$

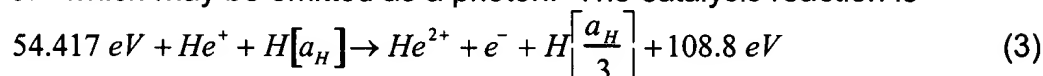
replaces the well known parameter  $n = \text{integer}$  in the Rydberg equation for hydrogen excited states. Thus, the Rydberg states are extended to lower levels as depicted in Figure 9. The  $n = 1$  state of hydrogen and the

$n = \frac{1}{\text{integer}}$  states of hydrogen are nonradiative, but a transition between

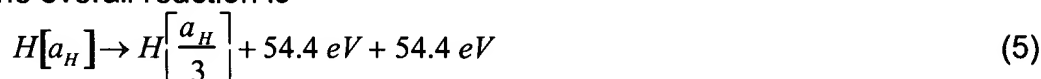
two nonradiative states is possible via a nonradiative energy transfer, say  $n = 1$  to  $n = 1/2$ . Thus, a catalyst provides a net positive enthalpy of reaction of  $m \cdot 27.2 \text{ eV}$  (i.e. it resonantly accepts the nonradiative energy transfer from hydrogen atoms and releases the energy to the surroundings to affect electronic transitions to fractional quantum energy levels). As a consequence of the nonradiative energy transfer, the hydrogen atom becomes unstable and emits further energy until it achieves a lower-energy nonradiative state having a principal energy level given by Eqs. (2a) and (2c).

The novel peaks fit two empirical relationships. In order of energy, the set comprising the peaks at  $91.2 \text{ nm}$ ,  $45.6 \text{ nm}$ ,  $30.4 \text{ nm}$ ,  $13.03 \text{ nm}$ ,  $10.13 \text{ nm}$ , and  $8.29 \text{ nm}$  correspond to energies of  $q \cdot 13.6 \text{ eV}$  where

$q = 1, 2, 3, 7, 9, 11$ . In order of energy, the set comprising the peaks at  $37.4 \text{ nm}$ ,  $20.5 \text{ nm}$ , and  $14.15 \text{ nm}$  correspond to energies of  $q \cdot 13.6 - 21.21 \text{ eV}$  where  $q = 4, 6, 8$ . These lines can be explained as electronic transitions to fractional Rydberg states of atomic hydrogen given by Eqs. (2a) and (2c) wherein the catalytic system involves helium ions because the second ionization energy of helium is  $54.417 \text{ eV}$ , which is equivalent to  $2 \cdot 27.2 \text{ eV}$ . In this case,  $54.417 \text{ eV}$  is transferred nonradiatively from atomic hydrogen to  $\text{He}^+$  which is resonantly ionized. The electron decays to the  $n = 1/3$  state with the further release of  $54.417 \text{ eV}$  which may be emitted as a photon. The catalysis reaction is

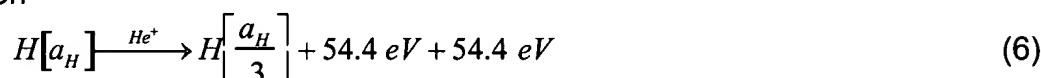


And, the overall reaction is



Since the products of the catalysis reaction have binding energies of  $m \cdot 27.2 \text{ eV}$ , they may further serve as catalysts. Thus, further catalytic transitions may occur:  $n = \frac{1}{3} \rightarrow \frac{1}{4}$ ,  $\frac{1}{4} \rightarrow \frac{1}{5}$ , and so on.

Electronic transitions to Rydberg states given by Eqs. (2a) and (2c) catalyzed by the resonant nonradiative transfer of  $m \cdot 27.2 \text{ eV}$  would give rise to a series of emission lines of energies  $q \cdot 13.6 \text{ eV}$  where  $q$  is an integer. It is further proposed that the photons that arise from hydrogen transitions may undergo inelastic helium scattering. That is, the catalytic reaction

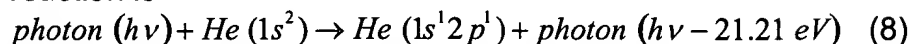


yields  $54.4 \text{ eV}$  by Eq. (4) and a photon of  $54.4 \text{ eV}$  ( $22.8 \text{ nm}$ ). Once emitted, the photon may be absorbed or scattered. When this photon strikes  $\text{He}(1s^2)$ ,  $21.2 \text{ eV}$  may be absorbed in the excitation to  $\text{He}(1s^1 2p^1)$ . This leaves a  $33.19 \text{ eV}$  ( $37.4 \text{ nm}$ ) photon peak and a  $21.21 \text{ eV}$  ( $58.4 \text{ nm}$ ) photon from  $\text{He}(1s^1 2p^1)$ . Thus, for helium the inelastic scattered peak of  $54.4 \text{ eV}$  photons from Eq. (3) is given by

$$E = 54.4 \text{ eV} - 21.21 \text{ eV} = 33.19 \text{ eV} \quad (37.4 \text{ nm}) \quad (7)$$

A novel peak shown in Figures 2-4 was observed at  $37.4 \text{ nm}$ .

Furthermore, the intensity of the  $58.4 \text{ nm}$  peak corresponding to the spectra shown in Figure 4 was about 60,000 photons/sec. Thus, the transition  $\text{He}(1s^2) \rightarrow \text{He}(1s^1 2p^1)$  dominated the inelastic scattering of EUV peaks. The general reaction is



The two empirical series may be combined—one directly from Eqs. (2a, 2c) and the other indirectly with Eq. (8). The energies for the novel lines in order of energy are  $13.6 \text{ eV}$ ,  $27.2 \text{ eV}$ ,  $40.8 \text{ eV}$ ,  $54.4 \text{ eV}$ ,  $81.6 \text{ eV}$ ,

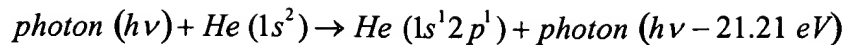
95.2 eV, 108.8 eV, 122.4 eV and 149.6 eV. The corresponding peaks are 91.2 nm, 45.6 nm, 30.4 nm, 37.4 nm, 20.5 nm, 13.03 nm, 14.15 nm, 10.13 nm, and 8.29 nm, respectively. Thus, the identified novel lines correspond to energies of  $q \cdot 13.6 \text{ eV}$ ,  $q = 1, 2, 3, 7, 9, 11$ . or  $q \cdot 13.6 \text{ eV}$ ,  $q = 4, 6, 8$  less 21.2 eV corresponding to inelastic scattering of these photons by helium atoms due to excitation of  $\text{He}(1s^2)$  to  $\text{He}(1s^1 2p^1)$ . The values of  $q$  observed are consistent with those expected based on Eq. (5) and the subsequent autocatalyzed reactions as discussed previously.<sup>128</sup> The broad satellite peak at 44.2 nm show in Figure 2-4 is consistent with the reaction mechanism of a nonradiative transfer to a catalyst followed by emission. There is remarkable agreement between the data and the proposed transitions to fractional Rydberg states and these lines inelastically scattered by helium according to Eq. (8). All other peaks could be assigned to He I, He II, second order lines, or atomic or molecular hydrogen emission. No known lines of helium or hydrogen explain the  $q \cdot 13.6 \text{ eV}$  related set of peaks.

In summary:

### The Novel Lines can be Explained as Electronic Transitions to Fractional Rydberg States of Atomic Hydrogen

- The novel peaks fit two empirical relationships.
- In order of energy, the set comprising the peaks at 91.2 nm, 45.6 nm, 30.4 nm, 13.03 nm, 10.13 nm, and 8.29 nm correspond to energies of  $q \cdot 13.6 \text{ eV}$  where  $q = 1, 2, 3, 7, 9$ , or 11.
- In order of energy, the set comprising the peaks at 63.3 nm, 37.4 nm, 20.5 nm, and 14.15 nm correspond to energies of  $q \cdot 13.6 - 21.21 \text{ eV}$  where  $q = 3, 4, 6$ , or 8.
- Electronic transitions to fractional Rydberg states given by
 
$$E_n = -\frac{e^2}{n^2 8\pi\epsilon_0 a_H} = -\frac{13.598 \text{ eV}}{n^2} \quad n = \frac{1}{2}, \frac{1}{3}, \frac{1}{4}, \dots, \frac{1}{p}; \quad p \text{ is an integer}$$
 catalyzed by the resonant nonradiative transfer of  $m \cdot 27.2 \text{ eV}$  would give rise to a series of emission lines of energies  $q \cdot 13.6 \text{ eV}$  where  $q$  is an integer.
- It is further proposed that the photons that arise from hydrogen transitions may undergo inelastic helium scattering. The general reaction is

<sup>128</sup> Reference No. 50.



• Then the two empirical series may be combined. The energies for the novel lines in order of energy are 13.6 eV, 27.2 eV, 40.8 eV, 54.4 eV, 81.6 eV, 95.2 eV, 108.8 eV, 122.4 eV and 149.6 eV. The corresponding peaks are 91.2 nm, 45.6 nm, 30.4 nm with 63.3 nm, 37.4 nm, 20.5 nm, 13.03 nm, 14.15 nm, 10.13 nm, and 8.29 nm, respectively. Thus, the identified novel lines correspond to energies of  $q \cdot 13.6 \text{ eV}$  where  $q = 1, 2, 3, 4, 6, 7, 8, 9$ , or 11 or these lines inelastically scattered by helium atoms wherein 21.2 eV was absorbed in the excitation of He ( $1s^2$ ) to He ( $1s^1 2p^1$ ).

The above explanation includes only a brief summary of the extensive experimental evidence submitted by Applicant, but makes quite clear that the experimental emissions of q obtained accurately match those of the predicted q values. Again, there is no requirement that each catalyst provide all lower-energy hydrogen states and possible emissions of q.

Article attachments 3, 81-84 and 89 present data that is predicted by Applicant's theory and confirm a novel reaction of atomic hydrogen which produces hydrogen in fractional quantum states that are at lower energies than the traditional "ground" ( $n = 1$ ) state, a chemically generated or assisted plasma (rt-plasma), and produces novel hydride compounds as detailed in the document "Lower-Energy Hydrogen Experimental Data". Exemplary results include:

33.) the observation of stationary inverted H Balmer and Lyman populations from a low pressure water-vapor microwave discharge plasma with an overpopulation sufficient for lasing was observed for Evenson microwave plasmas, but not for RF or discharge plasmas [59, 65-66, 68, 73, 83, 85],

35.) the observation of stationary inverted H Balmer and Lyman populations from a low pressure water-vapor microwave discharge plasma with an overpopulation sufficient for



lasing that was dependent on the pressure of the Evenson microwave plasma [59, 68, 73, 83, 85],

50.) the observation that microwave helium-hydrogen and argon-hydrogen plasmas having catalyst  $Ar^+$  or  $He^+$  showed extraordinary Balmer  $\alpha$  line broadening due to hydrogen catalysis corresponding to an average hydrogen atom temperature of 110 - 130  $eV$  and 180 - 210  $eV$ , respectively; whereas, plasmas of pure hydrogen, neon-hydrogen, krypton-hydrogen, and xenon-hydrogen showed no excessive broadening corresponding to an average hydrogen atom temperature of  $\approx 3 eV$  [33-37, 43, 49, 60, 63-64, 69, 71, 73-74, 82, 84, 88],

52.) the observation of significant Balmer  $\alpha$  line broadening of 17, 9, 11, 14, and 24  $eV$  from rt-plasmas of incandescently heated hydrogen with  $K^+ / K^+$ ,  $Rb^+$ , cesium, strontium, and strontium with  $Ar^+$  catalysts, respectively, wherein the results could not be explained by Stark or thermal broadening or electric field acceleration of charged species since the measured field of the incandescent heater was extremely weak, 1 V/cm, corresponding to a broadening of much less than 1  $eV$  [39, 42, 46, 51-52, 54-55, 57, 72, 81, 89, 91],

63.) the observation of energy balances of helium-hydrogen microwave plasmas of over 100 times the combustion of hydrogen and power densities greater than 10  $W/cm^3$  measured by water bath calorimetry [34-36, 50, 63, 71, 73, 76-78, 84, 92, 93, 101],

68.) the isolation of novel hydrogen compounds as products of the reaction of atomic hydrogen with atoms and ions which formed an anomalous plasma as reported in the EUV studies [6-10, 19, 25, 38, 41, 44-45, 60-62, 75, 81, 87, 90, 92, 93, 100, 101],

75.) the identification of novel hydride compounds by a number of analytical methods such as (i) time of flight secondary ion mass spectroscopy which showed a dominant hydride ion in the negative ion spectrum, (ii) X-ray photoelectron spectroscopy which showed novel hydride peaks and significant shifts of the core levels of the primary elements bound to the novel hydride ions, (iii)  $^1H$  nuclear magnetic resonance spectroscopy (NMR) which showed

extraordinary upfield chemical shifts compared to the NMR of the corresponding ordinary hydrides, and (iv) thermal decomposition with analysis by gas chromatography, and mass spectroscopy which identified the compounds as hydrides [6-10, 19, 25, 38, 41, 44-45, 60-62, 75, 81, 87, 90, 92, 93, 100],

Regarding the Committee's incorrect discrepancy:

The Novel Lines presented in Ref. [67]: R. L. Mills, P. Ray, "Extreme Ultraviolet Spectroscopy of Helium-Hydrogen Plasma", J. Phys. D, Applied Physics, Vol. 36, (2003), pp. 1535-1542 can be Explained as Electronic Transitions to Fractional Rydberg States of Atomic Hydrogen

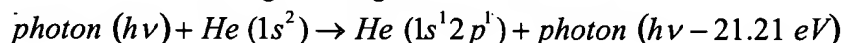
- The novel peaks fit two empirical relationships.
- In order of energy, the set comprising the peaks at 91.2 nm, 45.6 nm, 30.4 nm, 13.03 nm, 10.13 nm, and 8.29 nm correspond to energies of  $q \cdot 13.6 \text{ eV}$  where  $q = 1, 2, 3, 7, 9, \text{ or } 11$ .
- In order of energy, the set comprising the peaks at 63.3 nm, 37.4 nm, 20.5 nm, and 14.15 nm correspond to energies of  $q \cdot 13.6 - 21.21 \text{ eV}$  where  $q = 3, 4, 6, \text{ or } 8$ .

- Electronic transitions to fractional Rydberg states given by

$$E_n = -\frac{e^2}{n^2 8\pi\epsilon_0 a_H} = -\frac{13.598 \text{ eV}}{n^2} \quad n = \frac{1}{2}, \frac{1}{3}, \frac{1}{4}, \dots, \frac{1}{p}; \quad p \text{ is an integer}$$

catalyzed by the resonant nonradiative transfer of  $m \cdot 27.2 \text{ eV}$  would give rise to a series of emission lines of energies  $q \cdot 13.6 \text{ eV}$  where  $q$  is an integer.

- It is further proposed that the photons that arise from hydrogen transitions may undergo inelastic helium scattering. The general reaction is



- Then the two empirical series may be combined. The energies for the novel lines in order of energy are 13.6 eV, 27.2 eV, 40.8 eV, 54.4 eV, 81.6 eV, 95.2 eV, 108.8 eV, 122.4 eV and 149.6 eV. The corresponding peaks are 91.2 nm, 45.6 nm, 30.4 nm with 63.3 nm, 37.4 nm, 20.5 nm, 13.03 nm, 14.15 nm, 10.13 nm, and 8.29 nm, respectively. Thus, the identified novel

lines correspond to energies of  $q \cdot 13.6 \text{ eV}$  where  $q = 1, 2, 3, 4, 6, 7, 8, 9$ , or 11 or these lines inelastically scattered by helium atoms wherein 21.2 eV was absorbed in the excitation of  $\text{He}(1s^2)$  to  $\text{He}(1s^1 2p^1)$ .

Alternative explanations for these lines were eliminated as given, for example, in Ref. [67]: R. L. Mills, P. Ray, "Extreme Ultraviolet Spectroscopy of Helium-Hydrogen Plasma", J. Phys. D, Applied Physics, Vol. 36, (2003), pp. 1535-1542 and Ref. [98]: R. L. Mills, Y. Lu, J. He, M. Nansteel, P. Ray, X. Chen, A. Voigt, B. Dhandapani, "Spectral Identification of New States of Hydrogen", Applied Spectroscopy, submitted.

From Ref. [98]:

These strong emissions are not found in any single gas plasma, and cannot be assigned to the known emission of any species of the single gases studied such as  $H$ ,  $H^-$ ,  $H_2$ ,  $H_2^+$ ,  $H_3^+$ ,  $\text{He}$ ,  $\text{He}_2^+$ , and  $\text{He}^+$ , known species of the mixture such as  $\text{He}_2^+$ ,  $\text{HeH}^+$ ,  $\text{HeH}$ ,  $\text{HHe}_2^+$ , and  $\text{HHe}_n^+$  and  $\text{He}_n$ , possible contaminants [1], or doubly excited states [2].

However the results can be explained by a novel catalytic reaction involving atomic hydrogen [1, 3-6]

From Ref. [67]:

All known possibilities for the series of novel lines were considered. Spectra of species present in helium hydrogen mixtures and possible impurities were evaluated. The only known species in a helium-hydrogen plasmas are  $H^+$ ,  $H_2^+$ ,  $H_3^+$ ,  $H^-$ ,  $H$ ,  $H_2$ ,  $\text{He}_2^+$ ,  $\text{HeH}^+$ , and remotely possibly  $\text{HeH}$ . Other exotic possibilities such as  $\text{He}_2^+$ ,  $\text{HHe}_2^+$ ,  $\text{HHe}_n^+$  and  $\text{He}_n$  were eliminated due to the extremely specialized conditions required for their formation such as extremely low temperatures that were unlike those in the helium-hydrogen microwave plasmas [31-32]. The impurities considered were nitrogen, oxygen, carbon dioxide, and water vapor from air, noble gas contaminants, silicon from the quartz tube, and contaminants from the vacuum system.

Regarding hydrogen species as a candidate of the series of novel lines, hydrogen alone has no known emission in this region ( $< 77 \text{ nm}$ ) [5-25] as shown in Figure 1. This is a consequence of the binding energies of  $H$ ,  $H_2$ , and  $H_2^+$  being less than 16.3 eV [43-44], and the binding energy of  $H^-$  being only 0.75 eV [26]. The reaction to form  $H_3^+$  is exothermic [45]



From Eq. (1), the binding energy of  $H_3^+$  can not be more than 22.43 eV, the sum of the binding energy of  $H_2^+$ , 16.25 eV (given by the sum of the bond energy of  $H_2^+$ , 2.651 eV [44], and the binding energy of  $H$ , 13.59844 eV [43]), the bond energy of  $H_2$ , 4.478 eV [44], and 1.7 eV. The corresponding emission is 55.3 nm which is outside of the region of the novel series observed in the region  $< 50$  nm. Furthermore,  $H_3^+$  possesses no excited electronic states, and consequently has no observable emission in the ultraviolet or visible regions [27].  $H_3^+$  can only be observed spectroscopically via vibration-rotational transitions which are in the infrared [27-28].

$He_2^+$  emission is limited to the spectral region  $> 58.4$  nm; thus, it was eliminated [29].  $HeH^+$  was eliminated since excited states of this ion were predicted to be unstable or only weakly bonding [33].  $HeH$  emission was eliminated as the source of the series of novel peaks due to the extraordinarily low probability that  $HeH$  would form under the conditions of the helium-hydrogen microwave discharge. The existence of "bound" excited states of  $HeH$  has been shown by emission spectroscopy of  $HeH$  molecules produced by two ways: (1) by reactions of  $He$  and  $H_2^+$ , and (2) in charge exchange collisions between  $HeH^+$  and alkali vapors [34-35]. Conditions for either of these types of reactions were not present in the helium-hydrogen microwave plasmas. In addition, the known emission spectrum of  $HeH$  was not observed. In particular,  $HeH$  has broad emission peaks in the regions of 160-180 nm [36] and 200-400 nm [35] that were not observed in the helium-hydrogen plasmas, nor has the series of novel peaks been recorded on  $HeH$  emission. In addition, the novel series does not match the theoretical spectrum of attractive excited states that decay to a repulsive ground state. The theoretical emission of excited states belong to a Rydberg series that converges to the electronic ground state of the  $HeH^+$  ion [34-35].

Air contaminants were also eliminated. Plasmas of nitrogen, oxygen, carbon dioxide, or these gases with 2% hydrogen showed no emission in the region  $< 50$  nm as shown in Figure 5 for hydrogen mixed with nitrogen, oxygen, and carbon dioxide. In addition, water vapor present in the oxygen-hydrogen plasma showed no emission in this region. Nitrogen was further eliminated since the intensity of the  $NI\ 4S-4P$  peaks of the nitrogen microwave plasma at 113.45 nm and 119.96 nm were 500,000 photons/s; whereas, these peaks were absent from the helium-hydrogen emission recorded with the same sensitivity. The spectrum of nitrogen matched that given in the literature [46] and NIST tables [5]. Similarly oxygen, carbon dioxide, and water vapor (oxygen-hydrogen mixture) were eliminated since  $O\ I$  peaks were observed from each plasma with intensities  $> 100,000$  photons/s; whereas, these peaks were absent from the helium-hydrogen

emission recorded with the same sensitivity. The peaks that were absent from the helium-hydrogen microwave plasma, but were observed as intense peaks from the oxygen, carbon dioxide, and water vapor microwave plasmas were the O II peak at 83.45 nm and O I peaks at 87.79 nm, 93.5 nm, 99.1 nm, 103.92 nm, 104.09 nm, and 115.21 nm.

Emission of argon, krypton, and xenon as helium contaminants were eliminated. No emission was observed in the region  $<50$  nm for xenon, xenon-hydrogen, krypton, and krypton-hydrogen as shown in Figure 6 for krypton or xenon mixed with hydrogen. In the case of the argon plasma, only known Ar II and III lines were observed at shorter wavelengths as shown in Figure 7. More significantly, the Ar I lines at 93.2 nm, 104.82 nm, and 106.66 nm have an intensities that are about three orders of magnitude that of the Ar II lines at 48.72 nm, 54.76, and 55.68 nm as observed in the argon control and from NIST tables [5]. This and other lines of argon in the region 50 - 560 nm were not observed.

Neon has peaks at 45.635 nm and 45.527 nm. To eliminate the possibility that the 45.6 nm peak shown in Figures 2-4 was due to the presence of neon as an impurity, the EUV spectra (25 - 50 nm) of the helium-hydrogen mixture (98/2%) (top curve) and control neon (bottom curve) microwave discharge cell emission were recorded with a normal incidence EUV spectrometer and a CEM as shown in Figure 8. The novel lines were not observed in the neon control, and a series of Ne II lines were observed only in the control. The neon peaks at 45.635 nm and 45.527 nm were resolved in Figure 8; whereas, the 45.6 nm peak in the helium-hydrogen plasma was about 3 nm broad. Thus, it was not due to neon impurity. More significantly, the Ne I line at 73.58 nm has an intensity that is about three orders of magnitude that of the Ne II line at 45.635 nm and 45.527 nm as observed in the neon control and from NIST tables [5]. This and other lines of neon in the region 50 - 560 nm were not observed.

Silicon from the quartz tube wall was eliminated since emission due to Si I, Si II, or Si III is not possible below 56 nm based on the NIST tables [5]. Emission from silicon was also eliminated since no silicon lines were observed in any spectrum in the 5-560 nm region. Using the same quartz tube run under identical conditions, no emission was observed in the region of the novel series ( $< 50$  nm) in the case of the controls microwave discharge plasmas of hydrogen, nitrogen, oxygen, carbon dioxide, helium, krypton, xenon, or 2% hydrogen mixed with each of these gases except for helium.

Pump contaminants were eliminated. In order for pump contaminants to enter the region of the plasma, they must migrate against the pressure gradient of the differential

pumping,  $< 10^{-5}$  torr compared to 1 torr. This is highly unlikely. Furthermore, a turbo pump was used which does not have pump oil, and no impurities attributed to pumps were observed in any control spectrum in the 5-560 nm region.

The elimination of known explanations indicate a new result. Since the novel peaks were only observed with helium and hydrogen present, new hydrogen, helium, or helium-hydrogen species are possibilities. It is well known that empirically the excited energy states of atomic hydrogen are given by Rydberg equation (Eq. (2a) for  $n > 1$  in Eq. (2b)).

$$E_n = -\frac{e^2}{n^2 8 \pi \epsilon_0 a_H} = -\frac{13.598 \text{ eV}}{n^2} \quad (2a)$$

$$n = 1, 2, 3, \dots \quad (2b)$$

The  $n = 1$  state is the "ground" state for "pure" photon transitions (i.e. the  $n = 1$  state can absorb a photon and go to an excited electronic state, but it cannot release a photon and go to a lower-energy electronic state). However, an electron transition from the ground state to a lower-energy state may be possible by a resonant nonradiative energy transfer such as multipole coupling or a resonant collision mechanism. Processes such as hydrogen molecular bond formation that occur without photons and that require collisions are common [47]. Also, some commercial phosphors are based on resonant nonradiative energy transfer involving multipole coupling [48].

We propose that atomic hydrogen may undergo a catalytic reaction with certain atoms and ions such as  $He^+$  which singly or multiply ionize at integer multiples of the potential energy of atomic hydrogen,  $m \cdot 27.2 \text{ eV}$  wherein  $m$  is an integer. The theory was given previously [49]. The reaction involves a nonradiative energy transfer to form a hydrogen atom that is lower in energy than unreacted atomic hydrogen that corresponds to a fractional principal quantum number. That is

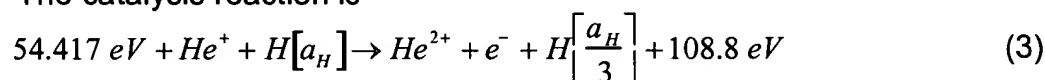
$$n = \frac{1}{2}, \frac{1}{3}, \frac{1}{4}, \dots, \frac{1}{p}; \quad p \text{ is an integer; } p \leq 137 \quad (2c)$$

replaces the well known parameter  $n = \text{integer}$  in the Rydberg equation for hydrogen excited states. Thus, the Rydberg states are extended to lower levels as depicted in Figure 9. The  $n = 1$  state of hydrogen and the  $n = \frac{1}{\text{integer}}$  states of hydrogen are

nonradiative, but a transition between two nonradiative states is possible via a nonradiative energy transfer, say  $n = 1$  to  $n = 1/2$ . Thus, a catalyst provides a net positive enthalpy of reaction of  $m \cdot 27.2 \text{ eV}$  (i.e. it resonantly accepts the nonradiative energy transfer from hydrogen atoms and releases the energy to the surroundings to affect electronic transitions to fractional quantum energy levels). As a consequence of the nonradiative energy transfer, the hydrogen atom becomes unstable and emits further

energy until it achieves a lower-energy nonradiative state having a principal energy level given by Eqs. (2a) and (2c).

The novel peaks fit two empirical relationships. In order of energy, the set comprising the peaks at 91.2 nm, 45.6 nm, 30.4 nm, 13.03 nm, 10.13 nm, and 8.29 nm correspond to energies of  $q \cdot 13.6 \text{ eV}$  where  $q = 1, 2, 3, 7, 9, 11$ . In order of energy, the set comprising the peaks at 37.4 nm, 20.5 nm, and 14.15 nm correspond to energies of  $q \cdot 13.6 - 21.21 \text{ eV}$  where  $q = 4, 6, 8$ . These lines can be explained as electronic transitions to fractional Rydberg states of atomic hydrogen given by Eqs. (2a) and (2c) wherein the catalytic system involves helium ions because the second ionization energy of helium is  $54.417 \text{ eV}$ , which is equivalent to  $2 \cdot 27.2 \text{ eV}$ . In this case,  $54.417 \text{ eV}$  is transferred nonradiatively from atomic hydrogen to  $\text{He}^+$  which is resonantly ionized. The electron decays to the  $n = 1/3$  state with the further release of  $54.417 \text{ eV}$  which may be emitted as a photon. The catalysis reaction is



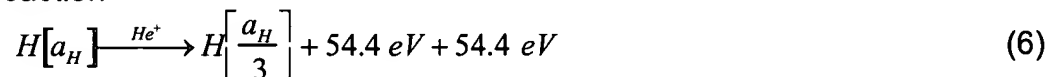
And, the overall reaction is



Since the products of the catalysis reaction have binding energies of  $m \cdot 27.2 \text{ eV}$ , they may further serve as catalysts. Thus, further catalytic transitions may occur:

$$n = \frac{1}{3} \rightarrow \frac{1}{4}, \frac{1}{4} \rightarrow \frac{1}{5}, \text{ and so on.}$$

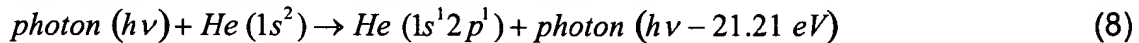
Electronic transitions to Rydberg states given by Eqs. (2a) and (2c) catalyzed by the resonant nonradiative transfer of  $m \cdot 27.2 \text{ eV}$  would give rise to a series of emission lines of energies  $q \cdot 13.6 \text{ eV}$  where  $q$  is an integer. It is further proposed that the photons that arise from hydrogen transitions may undergo inelastic helium scattering. That is, the catalytic reaction



yields  $54.4 \text{ eV}$  by Eq. (4) and a photon of  $54.4 \text{ eV}$  (22.8 nm). Once emitted, the photon may be absorbed or scattered. When this photon strikes  $\text{He}(1s^2)$ ,  $21.2 \text{ eV}$  may be absorbed in the excitation to  $\text{He}(1s^1 2p^1)$ . This leaves a  $33.19 \text{ eV}$  (37.4 nm) photon peak and a  $21.21 \text{ eV}$  (58.4 nm) photon from  $\text{He}(1s^1 2p^1)$ . Thus, for helium the inelastic scattered peak of  $54.4 \text{ eV}$  photons from Eq. (3) is given by

$$E = 54.4 \text{ eV} - 21.21 \text{ eV} = 33.19 \text{ eV} \text{ (37.4 nm)} \quad (7)$$

A novel peak shown in Figures 2-4 was observed at 37.4 nm. Furthermore, the intensity of the 58.4 nm peak corresponding to the spectra shown in Figure 4 was about 60,000 photons/sec. Thus, the transition  $He(1s^2) \rightarrow He(1s^1 2p^1)$  dominated the inelastic scattering of EUV peaks. The general reaction is



The two empirical series may be combined—one directly from Eqs. (2a, 2c) and the other indirectly with Eq. (8). The energies for the novel lines in order of energy are 13.6 eV, 27.2 eV, 40.8 eV, 54.4 eV, 81.6 eV, 95.2 eV, 108.8 eV, 122.4 eV and 149.6 eV. The corresponding peaks are 91.2 nm, 45.6 nm, 30.4 nm, 37.4 nm, 20.5 nm, 13.03 nm, 14.15 nm, 10.13 nm, and 8.29 nm, respectively. Thus, the identified novel lines correspond to energies of  $q \cdot 13.6 eV$ ,  $q = 1, 2, 3, 7, 9, 11$ . or  $q \cdot 13.6 eV$ ,  $q = 4, 6, 8$  less 21.2 eV corresponding to inelastic scattering of these photons by helium atoms due to excitation of  $He(1s^2)$  to  $He(1s^1 2p^1)$ . The values of  $q$  observed are consistent with those expected based on Eq. (5) and the subsequent autocatalyzed reactions as discussed previously [50]. The broad satellite peak at 44.2 nm show in Figure 2-4 is consistent with the reaction mechanism of a nonradiative transfer to a catalyst followed by emission. There is remarkable agreement between the data and the proposed transitions to fractional Rydberg states and these lines inelastically scattered by helium according to Eq. (8). All other peaks could be assigned to He I, He II, second order lines, or atomic or molecular hydrogen emission. No known lines of helium or hydrogen explain the  $q \cdot 13.6 eV$  related set of peaks.

The Committee cites Applicant's paper No. 28. R. Mills, P. Ray, "Spectral Emission of Fractional Quantum Energy Levels of Atomic Hydrogen from a Helium-Hydrogen Plasma and the Implications for Dark Matter", Int. J. Hydrogen Energy, (2002), Vol. 27, No. 3, pp. 301-322, as failing to identify the 304 Å line as the He II line. The Committee shows carelessness and has erred since Applicant has assigned the 304 Å to He II. Table 1 of gives:

304	304	$He^+(n=2) \rightarrow He^+(n=1) + 40.8 eV^b$	7, 8, 9, 10
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In the legend appears:



<sup>b</sup> In Figures 7, 8, 9, 10, and 12, the peak corresponding to  $He^+(n=3) \rightarrow He^+(n=1) + 48.35 \text{ eV}$  (256 Å) was absent which makes this assignment difficult.

Furthermore, in Sec. IIIA appears:

It is also proposed that the 304 Å peak shown in Figures 7, 8, 9, 10 and 12 was not entirely due to the He II transition. Conspicuously absent was the 256 Å (48.3 eV) line of He II shown in Figures 6 and 8 which implies only a minor He II transition contribution to the 304 Å peak.

The solar spectrum is not the same as the spectrum of a pure helium-hydrogen (98/2%) plasma. The Sun is known to contain the elements even beyond iron (See Table 4.2 of Stix, M., The Sun, Springer-Verlag, Berlin, (1991)). Based on the Committee's errors and using the same standard as the Committee applies to Applicant, his scientific credibility is compromised on **all** of his arguments.

Since the Committee simply ignored the extensive experimental evidence in attachments 3, 81-84 and 89 based on the erroneous belief that "[t]hey contain data which cannot be accounted for by applicant's theory," this experimental evidence should be considered in its entirety.

### **Category (5)**

On page 4 of the Final Office Action, the Committee further contends that Applicant's papers "[t]hey speculate hydrino formation as an explanation for experimental data unrelated to and not necessarily caused by hydrinos, such as Balmer line broadening, calorimetric data, or unfounded 'indications' of chemical bonding. See attached appendix, page 5, for alternate explanations consistent with conventional science. To this category belong attachments 1, 2, 7, 13, 18-22, 25-28 and 71-87."

The Committee is, once again, obviously confused. As given in Dr. Souw's Appendix, Applicant does not claim resonance broadening; rather, the source of Balmer line broadening is Doppler broadening. The resonance ionization involves the catalyst as given for the  $He^+$  in Ref. [67]. The catalyst reaction involves a nonradiative, resonant energy transfer of  $m \cdot 27.2 \text{ eV}$  to a catalyst with the remaining energy between the initial and final states being

released as a photon or transferred to a body such as H to form fast H. The resulting broadening is Doppler.

Plasma discharges such as RF, microwave, and high voltage glow discharges have been well characterized over decades. The plasma have been characterized by models such as coronal, Maxwellian, and Saha-Boltzmann as given in Griem [H. R. Griem, "Spectral Line Broadening in Plasmas", Academic Press, NY, 1978]. The mechanisms for broadening in these cells are discussed in many articles, such as the following:

1. M. Kuraica, N. Konjevic, "Line shapes of atomic hydrogen in a plane-cathode abnormal glow discharge", *Physical Review A*, Volume 46, No. 7, October (1992), pp. 4429-4432.
2. M. Kuraica, N. Konjevic, M. Platisa and D. Pantelic, *Spectrochimica Acta* Vol. 47, 1173 (1992).
3. I. R. Videnovic, N. Konjevic, M. M. Kuraica, "Spectroscopic investigations of a cathode fall region of the Grimm-type glow discharge", *Spectrochimica Acta*, Part B, Vol. 51, (1996), pp. 1707-1731.
4. S. Alexiou, E. Leboucher-Dalimier, "Hydrogen Balmer- $\alpha$  in dense plasmas", *Phys. Rev. E*, Vol. 60, No. 3, (1999), pp. 3436-3438.
5. S. Djurovic, J. R. Roberts, "Hydrogen Balmer alpha line shapes for hydrogen-argon mixtures in a low-pressure rf discharge", *J. Appl. Phys.*, Vol. 74, No. 11, (1993), pp. 6558-6565.
6. S. B. Radovanov, K. Dzierzega, J. R. Roberts, J. K. Olthoff, "Time-resolved Balmer-alpha emission from fast hydrogen atoms in low pressure, radio-frequency discharges in hydrogen", *Appl. Phys. Lett.*, Vol. 66, No. 20, (1995), pp. 2637-2639.
7. S. B. Radovanov, J. K. Olthoff, R. J. Van Brunt, S. Djurovic, "Ion kinetic-energy distributions and Balmer-alpha ( $H_\alpha$ ) excitation in  $Ar-H_2$  radio-frequency discharges", *J. Appl. Phys.*, Vol. 78, No. 2, (1995), pp. 746-757.

In general, the experimental profile is a convolution of a Doppler profile, an instrumental profile, the natural (lifetime) profile, Stark profiles, van der Waals profiles, a resonance profile, and fine structure. The contribution from each source in resonance transfer (rt)-plasmas of the present Invention was determined to be below the limit of detection as given in the following publications:

37. R. L. Mills, P. Ray, B. Dhandapani, R. M. Mayo, J. He, "Comparison of Excessive Balmer  $\alpha$  Line Broadening of Glow Discharge and Microwave Hydrogen Plasmas with Certain Catalysts", J. of Applied Physics, Vol. 92, No. 12, (2002), pp. 7008-7022.
49. R. L. Mills, P. Ray, B. Dhandapani, J. He, "Comparison of Excessive Balmer  $\alpha$  Line Broadening of Inductively and Capacitively Coupled RF, Microwave, and Glow Discharge Hydrogen Plasmas with Certain Catalysts", IEEE Transactions on Plasma Science, Vol. 31, No. (2003), pp. 338-355.
43. R. L. Mills, P. Ray, "Substantial Changes in the Characteristics of a Microwave Plasma Due to Combining Argon and Hydrogen", New Journal of Physics, www.njp.org, Vol. 4, (2002), pp. 22.1-22.17.
54. R. L. Mills, P. Ray, "Stationary Inverted Lyman Population Formed from Incandescently Heated Hydrogen Gas with Certain Catalysts", J. Phys. D, Applied Physics, Vol. 36, (2003), pp. 1504-1509.
20. R. Mills and M. Nansteel, P. Ray, "Argon-Hydrogen-Strontium Discharge Light Source", IEEE Transactions on Plasma Science, Vol. 30, No. 2, (2002), pp. 639-653.
16. R. Mills, M. Nansteel, and P. Ray, "Excessively Bright Hydrogen-Strontium Plasma Light Source Due to Energy Resonance of Strontium with Hydrogen", J. of Plasma Physics, Vol. 69, (2003), pp. 131-158.
52. R. Mills and M. Nansteel, P. Ray, "Bright Hydrogen-Light Source due to a Resonant Energy Transfer with Strontium and Argon Ions", New Journal of Physics, Vol. 4, (2002), pp. 70.1-70.28.
67. R. L. Mills, P. Ray, "Extreme Ultraviolet Spectroscopy of Helium-Hydrogen Plasma", J. Phys. D, Applied Physics, Vol. 36, (2003), pp. 1535-1542.
33. R. L. Mills, P. Ray, B. Dhandapani, M. Nansteel, X. Chen, J. He, "New Power Source from Fractional Quantum Energy Levels of Atomic Hydrogen that Surpasses Internal Combustion", J Mol. Struct., Vol. 643, No. 1-3, (2002), pp. 43-54.
51. R. Mills, P. Ray, R. M. Mayo, "CW H I Laser Based on a Stationary Inverted Lyman Population Formed from Incandescently Heated Hydrogen Gas with Certain Group I Catalysts", IEEE Transactions on Plasma Science, Vol. 31, No. 2, (2003), pp. 236-247.

The flow rate in Applicant's plasma cell is typically 10 sccm. At these low pressures, the flow is laminar (very low Reynolds number). An upper-limit estimate of the directionally-dependent Doppler broadening due to mass transport can be arrived at by assuming laminar flow at the maximum flow rate of 10 sccm. The cell pressure is about 1 Torr, and the temperature is about 1000 K; thus, the pressure and temperature corrected flow rate is about

25,000 ccm. A very conservative cross section of the plasma cell is  $1 \text{ cm}^2$ . Thus, the flow velocity is conservatively 4 m/s. This corresponds to a broadening of  $\sim 10^{-7}$  eV which is absolutely trivial—even much less than the 0.1 eV corresponding to the neutral gas temperature of 1000 K.

Broadening by high electron density is called Stark broadening. The required electron densities are about six orders of magnitude greater than the measured electron densities in these plasma [37, 43, 49]. Furthermore, only the atomic hydrogen lines ( $\alpha$ ,  $\beta$ ,  $\gamma$ , and  $\delta$ ) were found to be broadened. Stark broadening would result in broadening of ALL of the lines, not just the hydrogen lines. From R. L. Mills, P. Ray, E. Dayalan, B. Dhandapani, J. He, "Comparison of Excessive Balmer  $\alpha$  Line Broadening of Inductively and Capacitively Coupled RF, Microwave, and Glow Discharge Hydrogen Plasmas with Certain Catalysts", IEEE Transactions on Plasma Science, Vol. 31, No. (2003), pp. 338-355:

From Eq. (5), to get a Stark broadening of only 0.1 nm with  $T_e = 9000 \text{ K}$ , an electron density of about  $n_e \sim 3 \times 10^{15} \text{ cm}^{-3}$  is required, compared to that of the argon-hydrogen plasma of  $< 10^9 \text{ cm}^{-3}$  determined using a compensated Langmuir probe, over six orders of magnitude less. Regional maxima in electron densities that could give rise to Stark broadening was eliminated as a possibility. The measured electron densities did not exceed  $10^9 \text{ cm}^{-3}$ , and the axial variation was weak, showing less than a factor of two change throughout the brightest region of the plasma. The high mass diffusivity of all of the species present made it unlikely that a large density gradient existed anywhere in the plasma at steady state. This result was also evident by the good fit to a Gaussian profile recorded on the argon-hydrogen plasma rather than a Voigt profile as shown in Figure 10. In addition, the line broadening for Balmer  $\beta$ ,  $\gamma$ , and  $\delta$  was comparable to that of Balmer  $\alpha$ ; whereas, an absence of broadening beyond the instrument width was observed for the lines of argon or helium species such as the 667.73 nm and 591.2 nm Ar I lines and 667.816 nm and 587.56 nm He I lines. Thus, the Stark broadening was also insignificant.

Broadening was observed in glow discharge, RF discharge, and filament cells (rt-plasma) as well as microwave cells. Thus, the broadening is not dependent on the particular plasma source. Only those mixed plasma which contained a catalyst and hydrogen demonstrated broadening. Balmer  $\alpha$  line broadening is reported in Reference Nos. 16, 20,

30, 33-37, 39, 42-43, 49, 51-52, 54-55, 57, 63-65, 68-69, 71-74, 81-85, 88-89, 91, 92, 93. Standard broadening mechanisms were considered and eliminated, including pressure broadening, resonance broadening, and microwave field broadening. Applicant confirmed that Doppler broadening due to thermal motion was the dominant source to the extent that other sources may be neglected when each source was considered. In general, the experimental profile is a convolution of two Doppler profiles, an instrumental profile, the natural (lifetime) profile, Stark profiles, van der Waals profiles, a resonance profile, and fine structure. The contribution from each source was determined to be below the limit of detection as shown in:

- 49. R. L. Mills, P. Ray, E. Dayalan, B. Dhandapani, J. He, "Comparison of Excessive Balmer  $\alpha$  Line Broadening of Inductively and Capacitively Coupled RF, Microwave, and Glow Discharge Hydrogen Plasmas with Certain Catalysts", IEEE Transactions on Plasma Science, Vol. 31, No. (2003), pp. 338-355.
- 43. R. L. Mills, P. Ray, "Substantial Changes in the Characteristics of a Microwave Plasma Due to Combining Argon and Hydrogen", New Journal of Physics, www.njp.org, Vol. 4, (2002), pp. 22.1-22.17.
- 37. R. L. Mills, P. Ray, B. Dhandapani, R. M. Mayo, J. He, "Comparison of Excessive Balmer  $\alpha$  Line Broadening of Glow Discharge and Microwave Hydrogen Plasmas with Certain Catalysts", J. of Applied Physics, Vol. 92, No. 12, (2002), pp. 7008-7022.

No hydrogen species,  $H^+$ ,  $H_2^+$ ,  $H_3^+$ ,  $H^-$ ,  $H$ , or  $H_2$ , responds to the microwave field; rather, only the electrons respond. But, the measured electron temperature was about 1 eV; whereas, the measured H temperature was 110-130 eV. This requires that  $T_H \gg T_e$ .

Microwave-field broadening can not explain the results.

Pressure broadening is negligible as given in 37. R. L. Mills, P. Ray, B. Dhandapani, R. M. Mayo, J. He, "Comparison of Excessive Balmer  $\alpha$  Line Broadening of Glow Discharge and Microwave Hydrogen Plasmas with Certain Catalysts", J. of Applied Physics, Vol. 92, No. 12, (2002), pp. 7008-7022:

As discussed above, an estimate based on emission line profiles places the total H atom density of the argon-hydrogen plasma at  $\sim 3.5 \times 10^{14} \text{ cm}^{-3}$ . Since this is overwhelmingly dominated by the ground state,  $N_H = 3.5 \times 10^{14} \text{ cm}^{-3}$  will be used. Usually, the atomic

hydrogen collisional cross section in plasmas is on the order of  $10^{-18} \text{ cm}^2$  [38]. Thus, for  $N_H = 3.5 \times 10^{14} \text{ cm}^{-3}$ , collisional or pressure broadening is negligible.

The data supports the claimed chemical reaction between atomic hydrogen and a catalyst to form lower-energy state hydrogen with the release of energy. That energy is the source of the observed extraordinary Doppler broadened hydrogen lines as discussed previously [Ref. 95] with additional supporting data, such as the observation of the spectral lines of lower-energy hydrogen.

Similarly, power is required to maintain a plasma. The formation of lower-energy hydrogen from atomic hydrogen is the power source of chemically generated plasmas. Confirming data of rt-plasmas are reported in the following journal articles:

54. R. L. Mills, P. Ray, "Stationary Inverted Lyman Population Formed from Incandescently Heated Hydrogen Gas with Certain Catalysts", J. Phys. D, Applied Physics, Vol. 36, (2003), pp. 1504-1509.
20. R. Mills and M. Nansteel, P. Ray, "Argon-Hydrogen-Strontium Discharge Light Source", IEEE Transactions on Plasma Science, Vol. 30, No. 2, (2002), pp. 639-653.
16. R. Mills, M. Nansteel, and P. Ray, "Excessively Bright Hydrogen-Strontium Plasma Light Source Due to Energy Resonance of Strontium with Hydrogen", J. of Plasma Physics, Vol. 69, (2003), pp. 131-158.
52. R. Mills and M. Nansteel, P. Ray, "Bright Hydrogen-Light Source due to a Resonant Energy Transfer with Strontium and Argon Ions", New Journal of Physics, Vol. 4, (2002), pp. 70.1-70.28.
51. R. Mills, P. Ray, R. M. Mayo, "CW H I Laser Based on a Stationary Inverted Lyman Population Formed from Incandescently Heated Hydrogen Gas with Certain Group I Catalysts", IEEE Transactions on Plasma Science, Vol. 31, No. 2, (2003), pp. 236-247.
47. H. Conrads, R. Mills, Th. Wrubel, "Emission in the Deep Vacuum Ultraviolet from a Plasma Formed by Incandescently Heating Hydrogen Gas with Trace Amounts of Potassium Carbonate", Plasma Sources Science and Technology, Vol. 12, (2003), pp. 389-395.

As discussed in the literature and shown herein, the Committee's assertion regarding the broadening observed in cells that contain atomic hydrogen and a catalyst can not be explained by turbulence, electron density effect (Stark broadening), microwave-field, or

pressure broadening. In contrast, the broadening predicted by Applicant's reaction of the catalysis of atomic hydrogen to lower-energy states was actually observed.

Plasma discharges such as RF, microwave, and high voltage glow discharges have been well characterized over decades. The plasma have been characterized by models such as coronal, Maxwellian, and Saha-Boltzmann as given in Griem.<sup>129</sup> These plasmas cells are not stars. The mechanisms for broadening in these cells are discussed in many articles such as the following:

1. M. Kuraica, N. Konjevic, "Line shapes of atomic hydrogen in a plane-cathode abnormal glow discharge", *Physical Review A*, Volume 46, No. 7, October (1992), pp. 4429-4432.
2. M. Kuraica, N. Konjevic, M. Platisa and D. Pantelic, *Spectrochimica Acta* Vol. 47, 1173 (1992).
3. I. R. Videnovic, N. Konjevic, M. M. Kuraica, "Spectroscopic investigations of a cathode fall region of the Grimm-type glow discharge", *Spectrochimica Acta*, Part B, Vol. 51, (1996), pp. 1707-1731.
4. S. Alexiou, E. Leboucher-Dalimier, "Hydrogen Balmer- $\alpha$  in dense plasmas", *Phys. Rev. E*, Vol. 60, No. 3, (1999), pp. 3436-3438.
5. S. Djurovic, J. R. Roberts, "Hydrogen Balmer alpha line shapes for hydrogen-argon mixtures in a low-pressure rf discharge", *J. Appl. Phys.*, Vol. 74, No. 11, (1993), pp. 6558-6565.
6. S. B. Radovanov, K. Dzierzega, J. R. Roberts, J. K. Olthoff, "Time-resolved Balmer-alpha emission from fast hydrogen atoms in low pressure, radio-frequency discharges in hydrogen", *Appl. Phys. Lett.*, Vol. 66, No. 20, (1995), pp. 2637-2639.
7. S. B. Radovanov, J. K. Olthoff, R. J. Van Brunt, S. Djurovic, "Ion kinetic-energy distributions and Balmer-alpha ( $H_\alpha$ ) excitation in  $Ar - H_2$  radio-frequency discharges", *J. Appl. Phys.*, Vol. 78, No. 2, (1995), pp. 746-757.

In general, the experimental profile is a convolution of a Doppler profile, an instrumental profile, the natural (lifetime) profile, Stark profiles, van der Waals profiles, a

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<sup>129</sup> H. R. Griem, "Spectral Line Broadening in Plasmas", Academic Press, NY, 1978.

resonance profile, and fine structure. The contribution from each source in resonance transfer (rt)-plasmas of the present Invention was determined to be below the limit of detection as given in the following publications:

37. R. L. Mills, P. Ray, B. Dhandapani, R. M. Mayo, J. He, "Comparison of Excessive Balmer  $\alpha$  Line Broadening of Glow Discharge and Microwave Hydrogen Plasmas with Certain Catalysts", J. of Applied Physics, Vol. 92, No. 12, (2002), pp. 7008-7022.
49. R. L. Mills, P. Ray, B. Dhandapani, J. He, "Comparison of Excessive Balmer  $\alpha$  Line Broadening of Inductively and Capacitively Coupled RF, Microwave, and Glow Discharge Hydrogen Plasmas with Certain Catalysts", IEEE Transactions on Plasma Science, Vol. 31, No. (2003), pp. 338-355.
43. R. L. Mills, P. Ray, "Substantial Changes in the Characteristics of a Microwave Plasma Due to Combining Argon and Hydrogen", New Journal of Physics, www.njp.org, Vol. 4, (2002), pp. 22.1-22.17.
54. R. L. Mills, P. Ray, "Stationary Inverted Lyman Population Formed from Incandescently Heated Hydrogen Gas with Certain Catalysts", J. Phys. D, Applied Physics, Vol. 36, (2003), pp. 1504-1509.
20. R. Mills and M. Nansteel, P. Ray, "Argon-Hydrogen-Strontium Discharge Light Source", IEEE Transactions on Plasma Science, Vol. 30, No. 2, (2002), pp. 639-653.
16. R. Mills, M. Nansteel, and P. Ray, "Excessively Bright Hydrogen-Strontium Plasma Light Source Due to Energy Resonance of Strontium with Hydrogen", J. of Plasma Physics, Vol. 69, (2003), pp. 131-158.
52. R. Mills and M. Nansteel, P. Ray, "Bright Hydrogen-Light Source due to a Resonant Energy Transfer with Strontium and Argon Ions", New Journal of Physics, Vol. 4, (2002), pp. 70.1-70.28.
67. R. L. Mills, P. Ray, "Extreme Ultraviolet Spectroscopy of Helium-Hydrogen Plasma", J. Phys. D, Applied Physics, Vol. 36, (2003), pp. 1535-1542.
33. R. L. Mills, P. Ray, B. Dhandapani, M. Nansteel, X. Chen, J. He, "New Power Source from Fractional Quantum Energy Levels of Atomic Hydrogen that Surpasses Internal Combustion", J Mol. Struct., Vol. 643, No. 1-3, (2002), pp. 43-54.



51. R. Mills, P. Ray, R. M. Mayo, "CW H I Laser Based on a Stationary Inverted Lyman Population Formed from Incandescently Heated Hydrogen Gas with Certain Group I Catalysts", IEEE Transactions on Plasma Science, Vol. 31, No. 2, (2003), pp. 236-247.

The flow rate in Applicant's plasma cell is typically 10 sccm. At these low pressures, the flow is laminar (very low Reynolds number). A upper-limit estimate of the directionally-dependent Doppler broadening due to mass transport can be arrived at by assuming laminar flow at the maximum flow rate of 10 sccm. The cell pressure is about 1 Torr, and the temperature is about 1000 K; thus, the pressure and temperature corrected flow rate is about 25,000 ccm. A very conservative cross section of the plasma cell is  $1 \text{ cm}^2$ . Thus, the flow velocity is conservatively 4 m/s. This corresponds to a broadening of  $\sim 10^{-7}$  eV which is absolutely trivial—even much less than the 0.1 eV corresponding to the neutral gas temperature of 1000 K.

Broadening by high electron density is called Stark broadening. The required electron densities are about six orders of magnitude greater than the measured electron densities in these plasma.<sup>130</sup> Furthermore, only the atomic hydrogen lines ( $\alpha$ ,  $\beta$ ,  $\gamma$ , and  $\delta$ ) were found to be broadened. Stark broadening would result in broadening of ALL of the lines, not just the hydrogen lines. From R. L. Mills, P. Ray, E. Dayalan, B. Dhandapani, J. He, "Comparison of Excessive Balmer  $\alpha$  Line Broadening of Inductively and Capacitively Coupled RF, Microwave, and Glow Discharge Hydrogen Plasmas with Certain Catalysts", IEEE Transactions on Plasma Science, Vol. 31, No. (2003), pp. 338-355:

From Eq. (5), to get a Stark broadening of only 0.1 nm with  $T_e = 9000 \text{ K}$ , an electron density of about  $n_e \sim 3 \times 10^{15} \text{ cm}^{-3}$  is required, compared to that of the argon-hydrogen plasma of  $< 10^9 \text{ cm}^{-3}$  determined using a compensated Langmuir probe, over six orders of magnitude less. Regional maxima in electron densities that could give rise to Stark broadening was eliminated as a possibility. The measured electron densities did not exceed  $10^9 \text{ cm}^{-3}$ , and the axial variation was weak, showing less than a factor of two change throughout the brightest region of the plasma. The high mass diffusivity of all of the species present made it unlikely that a large density gradient existed anywhere in the plasma at steady state. This result was also evident by the good fit to a

<sup>130</sup> Reference Nos. 37, 43 and 49.

Gaussian profile recorded on the argon-hydrogen plasma rather than a Voigt profile as shown in Figure 10. In addition, the line broadening for Balmer  $\beta$ ,  $\gamma$ , and  $\delta$  was comparable to that of Balmer  $\alpha$ ; whereas, an absence of broadening beyond the instrument width was observed for the lines of argon or helium species such as the 667.73 nm and 591.2 nm Ar I lines and 667.816 nm and 587.56 nm He I lines. Thus, the Stark broadening was also insignificant.

Broadening was observed in glow discharge, RF discharge, and filament cells (rt-plasma), as well as microwave cells. Thus, the broadening is not dependent on the particular plasma source. Only those mixed plasma which contained a catalyst and hydrogen demonstrated broadening. Balmer  $\alpha$  line broadening is reported in reference Nos. 16, 20, 30, 33-37, 39, 42-43, 49, 51-52, 54-55, 57, 63-65, 68-69, 71-74, 81-85, 88-89, 91, 92, 93, 95-97 and 100. Standard broadening mechanisms were considered and eliminated, including pressure broadening, resonance broadening, and microwave field broadening. Applicant confirmed that Doppler broadening due to thermal motion was the dominant source to the extent that other sources may be neglected when each source was considered. In general, the experimental profile is a convolution of two Doppler profiles, an instrumental profile, the natural (lifetime) profile, Stark profiles, van der Waals profiles, a resonance profile, and fine structure. The contribution from each source was determined to be below the limit of detection as shown in:

49. R. L. Mills, P. Ray, E. Dayalan, B. Dhandapani, J. He, "Comparison of Excessive Balmer  $\alpha$  Line Broadening of Inductively and Capacitively Coupled RF, Microwave, and Glow Discharge Hydrogen Plasmas with Certain Catalysts", IEEE Transactions on Plasma Science, Vol. 31, No. (2003), pp. 338-355.
43. R. L. Mills, P. Ray, "Substantial Changes in the Characteristics of a Microwave Plasma Due to Combining Argon and Hydrogen", New Journal of Physics, www.njp.org, Vol. 4, (2002), pp. 22.1-22.17.
37. R. L. Mills, P. Ray, B. Dhandapani, R. M. Mayo, J. He, "Comparison of Excessive Balmer  $\alpha$  Line Broadening of Glow Discharge and Microwave Hydrogen Plasmas with Certain Catalysts", J. of Applied Physics, Vol. 92, No. 12, (2002), pp. 7008-7022.

In addition, only those plasma that contained a catalyst with hydrogen demonstrated other unique features such as the formation of a chemically generated

hydrogen plasma (rt-plasma), novel spectral lines corresponding to lower-energy hydrogen states, and inverted hydrogen populations as discussed in:

84. R. L. Mills, P. Ray, J. Dong, M. Nansteel, R. M. Mayo, B. Dhandapani, X. Chen, "Comparison of Balmer  $\alpha$  Line Broadening and Power Balances of Helium-Hydrogen Plasma Sources", Plasma Sources Science and Technology, submitted.
74. R. L. Mills, P. C. Ray, R. M. Mayo, M. Nansteel, B. Dhandapani, J. Phillips, "Spectroscopic Study of Unique Line Broadening and Inversion in Low Pressure Microwave Generated Water Plasmas", Physics of Plasmas, submitted.

Additional data confirming the novel claimed reaction of atomic hydrogen that results in extraordinary H energy as measured by the broadening of the Balmer  $\alpha$  line include:

- 18.) the observation by gas chromatography that hydrogen was consumed by the helium-hydrogen plasmas which showed the novel EUV series of lines with energies of  $q \cdot 13.6 \text{ eV}$ , the novel series of spectral lines due to the reaction  $2H(1/2) \rightarrow H_2(1/2)$  with vibronic coupling at energies of  $E_{D+vib} = 17.913 \pm \left(\frac{\nu^*}{3}\right) 0.515902 \text{ eV}$ , extraordinary H Balmer line broadening corresponding to 180 - 210 eV, and excess power of 21.9 W in  $3 \text{ cm}^3$ ,<sup>131</sup>
- 29.) the observation of stationary inverted H Balmer and Lyman populations from a low pressure water-vapor microwave discharge plasma with an overpopulation sufficient for lasing at wavelengths over a wide range from micron to blue wherein molecular oxygen served as the catalyst as supported by  $O^{2+}$  emission and H Balmer line broadening of 55 eV compared to 1 eV for hydrogen alone,<sup>132</sup>
- 30.) the observation of H Balmer line broadening of 55 eV compared to 1 eV for hydrogen alone at distances up to 5 cm from the coupler,<sup>133</sup>
- 49.) the observation that glow discharge plasmas of the catalyst-hydrogen mixtures of strontium-hydrogen, helium-hydrogen, argon-hydrogen, strontium-helium-hydrogen, and strontium-argon-hydrogen showed

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<sup>131</sup> Reference No. 76

<sup>132</sup> Reference Nos. 59, 65-66, 68, 74, 83, 85

<sup>133</sup> Reference No. 74

significant Balmer  $\alpha$  line broadening corresponding to an average hydrogen atom temperature of 25 - 45 eV; whereas, plasmas of the noncatalyst-hydrogen mixtures of pure hydrogen, krypton-hydrogen, xenon-hydrogen, and magnesium-hydrogen showed no excessive broadening corresponding to an average hydrogen atom temperature of  $\approx 3$  eV,<sup>134</sup>

50.) the observation that microwave helium-hydrogen and argon-hydrogen plasmas having catalyst  $Ar^+$  or  $He^+$  showed extraordinary Balmer  $\alpha$  line broadening due to hydrogen catalysis corresponding to an average hydrogen atom temperature of 110 - 130 eV and 180 - 210 eV, respectively; whereas, plasmas of pure hydrogen, neon-hydrogen, krypton-hydrogen, and xenon-hydrogen showed no excessive broadening corresponding to an average hydrogen atom temperature of  $\approx 3$  eV,<sup>135</sup>

52.) the observation of significant Balmer  $\alpha$  line broadening of 17, 9, 11, 14, and 24 eV from rt-plasmas of incandescently heated hydrogen with  $K^+ / K^+$ ,  $Rb^+$ , cesium, strontium, and strontium with  $Ar^+$  catalysts, respectively, wherein the results could not be explained by Stark or thermal broadening or electric field acceleration of charged species since the measured field of the incandescent heater was extremely weak, 1 V/cm, corresponding to a broadening of much less than 1 eV,<sup>136</sup>

In a recent article, Applicant reports for the first time that extraordinary broadening of 200 eV is observed in the claimed rt-plasma that is time dependent. This further eliminates known ionization (electron density), turbulence, or field dependent mechanisms as discussed in:

95. R. L. Mills, P. Ray, B. Dhandapani, "Excessive Balmer  $\alpha$  Line Broadening of Water-Vapor Capacitively-Coupled RF Discharge Plasmas" IEEE Transactions on Plasma Science, submitted.

The abstract states:

From the width of the emitted 656.3 nm Balmer  $\alpha$  line, it was found that water-vapor capacitively-coupled RF discharge plasmas showed two populations. A typical slow population was observed that was independent of time, and a new phenomenon, an extraordinary fast population that increased from zero to a significant portion of the Balmer  $\alpha$  emission with time, was also observed under no-flow conditions. The

<sup>134</sup> Reference Nos. 16, 20, 30, 52, 72

<sup>135</sup> Reference Nos. 33-37, 43, 49, 60, 63-64, 69, 71, 73-74, 82, 84, 88, 92, 93

<sup>136</sup> Reference Nos. 39, 42, 46, 51-52, 54-55, 57, 72, 81, 89, 91

peak width and energy also increased with time up to a 0.7 nm half-width corresponding to an average hydrogen atom energy of 200 eV. Stark broadening or acceleration of charged species due to high electric fields can not explain the results since the electron density was low, the RF field was constant with time, and only the atomic hydrogen lines were broadened. Rather, an energetic chemical reaction is proposed as the source of the excessive line broadening involving a resonant energy transfer between atomic hydrogen and oxygen where the rate increases with the duration of the discharge.

Pressure broadening is negligible as given in Reference No. 37. R. L. Mills, P. Ray, B. Dhandapani, R. M. Mayo, J. He, "Comparison of Excessive Balmer  $\alpha$  Line Broadening of Glow Discharge and Microwave Hydrogen Plasmas with Certain Catalysts", J. of Applied Physics, Vol. 92, No. 12, (2002), pp. 7008-7022:

As discussed above, an estimate based on emission line profiles places the total H atom density of the argon-hydrogen plasma at  $\sim 3.5 \times 10^{14} \text{ cm}^{-3}$ . Since this is overwhelmingly dominated by the ground state,  $N_H = 3.5 \times 10^{14} \text{ cm}^{-3}$  will be used. Usually, the atomic hydrogen collisional cross section in plasmas is on the order of  $10^{-18} \text{ cm}^2$ . Thus, for  $N_H = 3.5 \times 10^{14} \text{ cm}^{-3}$ , collisional or pressure broadening is negligible.

The experimental data supports the chemical reaction between atomic hydrogen and a catalyst to form lower-energy state hydrogen with the release of energy. This energy is the source of the observed extraordinary Doppler broadened hydrogen lines as discussed previously<sup>137</sup> with additional supporting data such as the observation of the spectral lines of lower-energy hydrogen.

Similarly, power is required to maintain a plasma. The formation of lower-energy hydrogen from atomic hydrogen is the power source of chemically generated plasmas of the present Invention. Confirming data of rt-plasmas are reported in the following journal articles:

54. R. L. Mills, P. Ray, "Stationary Inverted Lyman Population Formed from Incandescently Heated Hydrogen Gas with Certain Catalysts", J. Phys. D, Applied Physics, Vol. 36, (2003), pp. 1504-1509.

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<sup>137</sup> Reference No. 95

20. R. Mills and M. Nansteel, P. Ray, "Argon-Hydrogen-Strontium Discharge Light Source", IEEE Transactions on Plasma Science, Vol. 30, No. 2, (2002), pp. 639-653.
16. R. Mills, M. Nansteel, and P. Ray, "Excessively Bright Hydrogen-Strontium Plasma Light Source Due to Energy Resonance of Strontium with Hydrogen", J. of Plasma Physics, Vol. 69, (2003), pp. 131-158.
52. R. Mills and M. Nansteel, P. Ray, "Bright Hydrogen-Light Source due to a Resonant Energy Transfer with Strontium and Argon Ions", New Journal of Physics, Vol. 4, (2002), pp. 70.1-70.28.
51. R. Mills, P. Ray, R. M. Mayo, "CW H I Laser Based on a Stationary Inverted Lyman Population Formed from Incandescently Heated Hydrogen Gas with Certain Group I Catalysts", IEEE Transactions on Plasma Science, Vol. 31, No. 2, (2003), pp. 236-247.
47. H. Conrads, R. Mills, Th. Wrubel, "Emission in the Deep Vacuum Ultraviolet from a Plasma Formed by Incandescently Heating Hydrogen Gas with Trace Amounts of Potassium Carbonate", Plasma Sources Science and Technology, Vol. 12, (2003), pp. 389-395.

The Committee should be aware that these discharges are not fully ionized. The ionization fraction of these plasma is very low, typically  $10^{-6}$ .<sup>138</sup> This is also consistent with the measured electron density of  $< 10^9 \text{ cm}^{-3}$ <sup>139</sup> compared to the gas density at 1 Torr and 1000 K of  $10^{15} \text{ cm}^{-3}$ . Thus, the atomic hydrogen available for the catalysis reaction is essentially the total.

R. Mills, K. Akhtar, B. Dhandapani, "Tests of Features of Field-Acceleration

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<sup>138</sup> See M. Kuraica, N. Konjevic, "Line shapes of atomic hydrogen in a plane-cathode abnormal glow discharge", Physical Review A, Volume 46, No. 7, October (1992), pp. 4429-4432; M. Kuraica, N. Konjevic, M. Platisa and D. Pantelic, *Spectrochimica Acta* Vol. 47, 1173 (1992); I. R. Videnovic, N. Konjevic, M. M. Kuraica, "Spectroscopic investigations of a cathode fall region of the Grimm-type glow discharge", *Spectrochimica Acta*, Part B, Vol. 51, (1996), pp. 1707-1731; S. Alexiou, E. Leboucher-Dalimier, "Hydrogen Balmer- $\alpha$  in dense plasmas", Phys. Rev. E, Vol. 60, No. 3, (1999), pp. 3436-3438; S. Djurovic, J. R. Roberts, "Hydrogen Balmer alpha line shapes for hydrogen-argon mixtures in a low-pressure rf discharge", J. Appl. Phys., Vol. 74, No. 11, (1993), pp. 6558-6565; S. B. Radovanov, K. Dzierzega, J. R. Roberts, J. K. Olthoff, "Time-resolved Balmer-alpha emission from fast hydrogen atoms in low pressure, radio-frequency discharges in hydrogen", Appl. Phys. Lett., Vol. 66, No. 20, (1995), pp. 2637-2639; S. B. Radovanov, J. K. Olthoff, R. J. Van Brunt, S. Djurovic, "Ion kinetic-energy distributions and Balmer-alpha ( $H_\alpha$ ) excitation in  $Ar - H_2$  radio-frequency discharges", J. Appl. Phys., Vol. 78, No. 2, (1995), pp. 746-757, and H. R. Griem, "Spectral Line Broadening in Plasmas", Academic Press, NY, 1978.

<sup>139</sup> Reference Nos. 37, 43

Models for the Extraordinary Selective H Balmer  $\alpha$  Broadening in Certain Hydrogen Mixed Plasmas" (June 24, 2005, [www.blacklightpower.com](http://www.blacklightpower.com)) discloses extensive test results that conclusively disprove the Committee's alleged alternate explanation for balmer line broadening:

The validity of field-acceleration models to explain selective broadening in hydrogen-mixed plasmas was investigated by mapping the width of the emitted 656.3 nm Balmer  $\alpha$  line from glow discharge  $Ar/H_2$  (95/5%) as well as  $He/H_2$  (95/5%) plasmas as a function of gas pressure and field strength using a cell with needle-like electrodes (fine-tip tungsten electrodes of 3 mm diameter). To explain the symmetrical (Gaussian) peak shape of selective, extraordinary broadening of the hydrogen Balmer lines, field-acceleration mechanisms require a "reflector" to reverse the momentum of positive ions gained from the electric field to give rise to fast H going away from the cathode in the same abundance as that moving towards the cathode. Not only does the reflector have to have a production efficiency of unity in the reverse-electric-field direction, but to be consistent with observations, a "divertor" must also exist such that the ratio of fast H of any given energy towards and away from the cathode remains equal while the equal ratio is also formed in all directions including the direction perpendicular to the field. The existence of an ideal reflector was tested by elimination of the possible candidates, the plane cathode or gas matrix, proposed in the latest versions of field-acceleration models by using needle electrodes and by decreasing the plasma-gas pressure by over an order of magnitude, respectively. No effect on the symmetrical broadening was observed. Furthermore, field-acceleration models require that the broadening is predominant in the cathode fall region along the direction of the strong field and is essentially zero everywhere except here where the high voltage drop occurs. But, the boardening was mapped throughout the cell and no position effect was observed including perpendicular to the field and in regions far from the high-field regions. The field dependence was directly tested by varying the applied voltages, and again no effect was observed over the applied-voltage range of 475-620 V. Moreover, in former reports, the feature of the requirement of a divertor was ignored or argued not to exist despite data to the contrary showing that the broadening was independent of angle with respect to the field. Inescapable failings of all field-acceleration models are that the broadening was the same parallel as it was perpendicular to the field, and this broadening was undiminished even in regions where there was no high field. An energetic chemical reaction of hydrogen as the source of broadening explains the isotropic effect, the selective H broadening, the lack of a requirement for a divertor or reflector, the new feature reported by the authors of time dependence, lack of an

applied-field dependence, and the observation that only particular hydrogen-mixed plasmas show the extraordinary broadening.

As discussed in the literature and shown herein, the Committee's assertion regarding the broadening observed in cells that contain atomic hydrogen and a catalyst can not be explained by turbulence, electron density effect (Stark broadening), or pressure broadening. In contrast, the broadening predicted by Applicant's reaction of the catalysis of atomic hydrogen to lower-energy states was actually observed. Thus, these references clearly support the formation of Applicant's lower-energy hydrogen technology.

#### **Category (6)**

The Committee's argument regarding "anomalous discharge" or "afterglow" on pages 4-5 of the Office Action demonstrates a clear lack of understanding of basic thermodynamics. By the same law that assures that the oceans will not spontaneously absorb energy from the atmosphere and become oxygen and hydrogen, the hydrino formation reaction is irreversible by absorption of thermal energies from the neutral gas of the plasma. Based on its misplaced conclusion, the Committee simply ignores the experimental evidence presented.

Studies that experimentally confirm a novel reaction of atomic hydrogen which produces hydrogen in fractional quantum states that are at lower energies than the traditional "ground" ( $n = 1$ ) state, a chemically generated or assisted plasma (rt-plasma), and produces novel hydride compounds include the observation of an anomalous plasma afterglow duration [12-13, 47, 81]. Exemplary studies include:

41.) the observation by the Institut für Niedertemperatur-Plasmaphysik e.V. of an anomalous plasma and plasma afterglow duration formed with hydrogen-potassium mixtures [13, 47, 81],

42.) the observation of anomalous afterglow durations of plasmas formed by catalysts providing a net enthalpy of reaction within thermal energies of  $m \cdot 27.28 \text{ eV}$  [12, 13, 47, 81],

In Sec. IIIC, of 37. R. L. Mills, P. Ray, B. Dhandapani, R. M. Mayo, J. He, "Comparison of Excessive Balmer  $\alpha$  Line Broadening of Glow Discharge and Microwave Hydrogen Plasmas



with Certain Catalysts", J. of Applied Physics, Vol. 92, No. 12, (2002), pp. 7008-7022 the catalysis reaction is discussed:

Rt-plasmas formed with hydrogen-potassium mixtures have been reported previously [41-42] wherein the plasma decayed with a two second half-life when the electric field was set to zero. This was the thermal decay time of the filament which dissociated molecular hydrogen to atomic hydrogen. This experiment showed that hydrogen line emission was occurring even though the voltage between the heater wires was set to and measured to be zero and indicated that the emission was due to a reaction of potassium atoms with atomic hydrogen. Potassium atoms ionize at an integer multiple of the potential energy of atomic hydrogen,  $m \cdot 27.2 \text{ eV}$ . The enthalpy of ionization of  $K$  to  $K^{3+}$  has a net enthalpy of reaction of  $81.7426 \text{ eV}$ , which is equivalent to  $m = 3$ .  $K^{3+}$  and the formation of the corresponding hydride were detected by EUV spectroscopy recorded on an rt-plasma [43].

A rt-plasma of hydrogen and certain alkali ions formed at low temperatures (e.g.  $\approx 10^3 \text{ K}$ ) as recorded via EUV spectroscopy, and an excessive afterglow duration was observed by hydrogen Balmer and alkali line emissions in the visible range [42]. The observed plasma formed from atomic hydrogen generated at a tungsten filament that heated a titanium dissociator and one of potassium, rubidium, cesium, and their carbonates and nitrates. These atoms and ions ionize to provide a net enthalpy of reaction of an integer multiple of the potential energy of atomic hydrogen ( $m \cdot 27.2 \text{ eV}$ ,  $m = \text{integer}$ ) to within  $0.17 \text{ eV}$  and comprise only a single ionization in the case of a potassium or rubidium ion. Whereas, the chemically similar atoms of sodium and sodium and lithium carbonates and nitrates which do not ionize with these constraints caused no emission. To test the electric dependence of the emission, the weak electric field of about  $1 \text{ V/cm}$  was set and measured to be zero in  $< 0.5 \times 10^{-6} \text{ sec}$ . An afterglow duration of about one to two seconds was recorded in the case of potassium, rubidium, cesium,  $K_2CO_3$ ,  $RbNO_3$ , and  $CsNO_3$ . Hydrogen line or alkali line emission was occurring even though the voltage between the heater wires was set to and measured to be zero. These atoms and ions ionize to provide a net enthalpy of reaction of an integer multiple of the potential energy of atomic hydrogen to within less than the thermal energies at  $\approx 10^3 \text{ K}$  and comprise only a single ionization in the case of a potassium or rubidium ion. Since the thermal decay time of the filament for dissociation of molecular hydrogen to atomic hydrogen was similar to the rt-plasma afterglow duration, the emission was determined to be due to a

reaction of atomic hydrogen with each of the atoms or ions that did not require the presence of an electric field to be functional.

41. R. Mills, "Temporal Behavior of Light-Emission in the Visible Spectral Range from a Ti-K<sub>2</sub>CO<sub>3</sub>-H-Cell", Int. J. Hydrogen Energy, Vol. 26, No. 4, (2001), pp. 327-332.
42. R. Mills, T. Onuma, and Y. Lu, "Formation of a Hydrogen Plasma from an Incandescently Heated Hydrogen-Catalyst Gas Mixture with an Anomalous Afterglow Duration", Int. J. Hydrogen Energy, Vol. 26, No. 7, July, (2001), pp. 749-762.
43. R. Mills, P. Ray, "Spectroscopic Identification of a Novel Catalytic Reaction of Potassium and Atomic Hydrogen and the Hydride Ion Product", Int. J. Hydrogen Energy, Vol. 27, No. 2, February, (2002), pp. 183-192.

The energy of recombining atomic hydrogen to molecular hydrogen is less than 4.5 eV; whereas, Balmer emission requires an excited state with  $n \geq 3$  corresponding to at least 12 eV and the ionization of hydrogen requires 13.6 eV; thus, the recombination of atomic hydrogen can not account for the hydrogen plasma emission. The only choice is an energetic chemical reaction as discussed in:

47. H. Conrads, R. Mills, Th. Wrubel, "Emission in the Deep Vacuum Ultraviolet from a Plasma Formed by Incandescently Heating Hydrogen Gas with Trace Amounts of Potassium Carbonate", Plasma Sources Science and Technology, Vol. 12, (2003), pp. 389-395.

From the Discussion section:

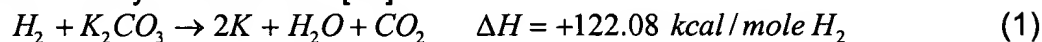
#### **IV. Discussion**

The emission of VUV radiation, and in particular, Lyman series and Werner band emission was observed from a low density plasma of quite moderate temperature similar to that in fluorescence tubes for general lighting. Such a plasma of an incandescently heated cell should not emit VUV radiation. The spectra showed that the plasma was far from thermal equilibrium. It was unlikely that the cell components, such as the heater and titanium mesh contributed to a non Maxwellian free-electron velocity distribution. And, if the velocity distribution of free electrons determined the population of the electronic levels, it must have been an unusual one because of the preference for emission from a few specific electronic states of low quantum number.

Without the combination of  $K_2CO_3$  and hydrogen, only blackbody radiation from the tungsten coil was observed at lower wavelengths. Based on the VUV emission, the plasma was predominately a hydrogen plasma. The ionization of atomic hydrogen requires 13.6 eV. In the cases where plasma was observed, no possible chemical reaction of the tungsten filament, the titanium screen,  $K_2CO_3$ , and low pressure hydrogen at a cell temperature of 750 °C could be found which accounted for the generation and sustaining of the plasma and observed spectra. In fact, no known chemical reaction releases enough energy to form an atomic hydrogen plasma of sufficient free electron and excitation temperature.

The enthalpy of formation  $\Delta H_p$  of potassium hydride is  $-14.13 \text{ kcal / mole}$  [19]. Thus, the formation of potassium hydride releases only 0.59 eV per atom. But, potassium hydride decomposes in this temperature range (288 to 415 °C). Thus, it can not account for any emission of the hydrogen plasma.

The reduction of  $K_2CO_3$  by hydrogen calculated from the heats of formation is very endothermic [20].



The reaction absorbs 2.5 eV per hydrogen atom.

The most energetic reaction possible with oxygen is the reaction of hydrogen to form water which releases 1.48 eV per atom of hydrogen; whereas, the energy of Lyman emission is greater than 10.2 eV per atom.

The dissociation of molecular hydrogen on the filament produces atomic hydrogen which may recombine to release 4.45 eV. Since atomic hydrogen is neutral, no contribution from the electric field of the filament was possible. Thus, excitation with energies of 4.45 eV or less was possible by the transport of thermal energy from the filament due to hydrogen dissociation followed by recombination. But this reaction is not sufficiently energetic to support the observed VUV emission.

Chemical energy may have been transported from regions outside of the annular region where most of the emission was observed. Dense and cold plasmas may have been created close to surfaces such as the titanium mesh due to chemical reactions. In such non ideal plasmas with electron densities close to solid density and temperatures below 0.5 eV, the potential energy of the electrons becomes comparable to their kinetic energy, and energy levels of bound electrons in atoms such as hydrogen are altered such that excitation and ionization energies are lowered [21]. This also applies to other elements of the plasma such as potassium. The electronic energy levels of the different species are further distorted when interacting with each other. The dissociation of molecules and ionization of both the molecules and atoms may become more probable with more species. However, the lowering of the ionization and excitation energies by the state of "non ideality" in dense plasmas is only about 1 eV even for potassium. Thus, the most energetic chemical source possible, dissociated atomic hydrogen, could not have provided more energy than

the Frank-Condon energy of 4.45 eV during recombination. Thus, a state of "non ideality" of the plasma can not explain the energetic processes of at least 10 eV. Furthermore, the electron density measured using a Langmuir probe was  $n_e = 2 \times 10^9 \text{ cm}^{-3}$  [12], 15 orders of magnitude less than solid density which eliminates any possibility of non ideality in these plasmas.

The measured electron temperature, 0.5 eV, was over an order of magnitude too low to account for the hydrogen plasma. The filament electric field as the energy source of the excitation was also eliminated. The emission occurred even when the electric field was set and measured to be zero. The results can not be explained by electric field acceleration of charged species since the estimated external field of the incandescent heater was extremely weak, about 1 V/cm. The electron mean free path at the operating pressure range of 0.1 to 1 mbar was about 0.1 cm corresponding to a mean energy from the acceleration of electrons in the field of about 1 V/cm of under 1 eV. Thus, electron collisional excitation of Lyman emission or hydrogen ionization by a so called 'run-way-situation' of the velocities of free electrons is not probable.

Temperature dependent electric fields also arise due to the greater mobility of electrons compared to ions. The generated voltage  $U$  for a plasma with a similar ion and electron temperature  $T$  is given by

$$U = \frac{kT}{2e} \ln \frac{m_x}{m_e} \quad (2)$$

where  $m_x$  is the mass of the ion such as the potassium ion or a proton,  $m_e$  is the electron mass, and  $e$  is the electron charge. From Eq. (2), the maximum voltage corresponding to the potassium ion is of the order of 1 V.

Excitation of hydrogen in one region of the cell with transport to produce excited state emission from the center of the cell was also eliminated as a possibility. Emission was observed from the gas in the annular space between the central filament and the outer titanium mesh. Since the lifetimes of H ( $n = 2$ ) and H ( $n = 3$ ) are each approximately  $10^{-8} \text{ s}$  and the average velocity of the fastest hydrogen atoms was  $< 10^5 \text{ m/s}$ , the excitation must have been local [22].

Multi-collisional processes may be possible [23], but very dense, high-pressure plasmas are required, and given an electron energy of 0.5 eV, about 30 concerted electron collisions would be required within  $10^{-8} \text{ s}$ —a definite impossibility.

Multiphoton absorption with excitation to intermediate virtual levels may be possible [24-26], but extraordinary power of the order of GW are required from pulsed lasers [27].

Resonant energy transfer from excited species to hydrogen atoms in the ground state is possible to give predominantly Lyman  $\alpha$  and Lyman  $\beta$  emission. Kurunczi, Shah, and Becker [23, 28-29] observed intense emission of Lyman  $\alpha$  and Lyman  $\beta$  radiation at 121.6 nm and 102.5 nm,

respectively, from microhollow cathode discharges in high-pressure Ne (740 Torr) with the addition of a small amount of hydrogen (up to 3 Torr). With essentially no molecular emission observed, Kurunczi et al. attributed the anomalous Lyman  $\alpha$  emission to the near-resonant energy transfer between the  $Ne_2^*$  excimer and  $H_2$  which leads to formation of  $H(n=2)$  atoms, and attributed the Lyman  $\beta$  emission to the near-resonant energy transfer between excited  $Ne^*$  atoms (or vibrationally excited neon excimer molecules) and  $H_2$  which leads to formation of  $H(n=3)$  atoms. However, the formation of this plasma resulting in  $Ne_2^*$  excimers and excited  $Ne^*$  atoms required a field of over  $10^4$  V/cm and a power density of several hundred kilowatts per  $cm^3$ . Whereas, the field in the heated cells was on the order of 1 V/cm, and power was only applied to the filament. Thus, this mechanism does not provide a source of energetic excited states that may resonantly transfer energy to atomic hydrogen.

The titanium-mesh and tungsten filament were present in all experiments. The emission was not observed with the cell alone, with hydrogen alone, or under identical conditions wherein  $Na_2CO_3$  replaced  $K_2CO_3$ . When the power was interrupted, the emission decayed in about two seconds. Decay was recorded over a time greater than 10,000 times the typical duration of a discharge plasma afterglow [30]. This experiment showed, that plasma emission was occurring even though the voltage between the heater wires was set to and measured to be zero for a time duration which was surprisingly extended. Since the thermal decay time of the filament for dissociation of molecular hydrogen to atomic hydrogen was similar to the plasma afterglow duration which required the presence of  $K_2CO_3$ , the emission was determined to be due to a reaction of  $K_2CO_3$  with atomic hydrogen. The minimum temperature requirement of the tungsten wire for emission also demonstrated the emission reaction's dependence on atomic hydrogen.

A source of energy other than that provided by the electric field or known chemical reactions must be considered for explaining our experimental findings.

## V. Conclusion

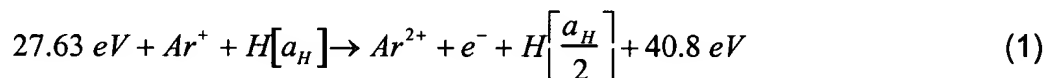
The generation of the Lyman and Balmer series and the Lyman Werner bands of molecular hydrogen requires energies significantly greater than 10 eV. The formation of a hydrogen plasma by the cell loaded with  $K_2CO_3$  on titanium and operated in hydrogen required a minimum temperature. The heat from the filament and possibly the weak dipole field from the filament may sustain the hydrogen plasma; but, the latter is not be essential because hydrogen lines were emitted during times when this voltage was set to zero. Furthermore, given the observations, free electrons could not excite these states. In the case that

the free electrons should have been thermalized, their temperature was too low to contribute to excitation or ionization even from the tail of the velocity distribution. Longer range fields (of the order of mm) were only about a 1 V/cm. In addition to electron collisional excitation, known chemical reactions, resonant photon transfer, and the lowering of the ionization and excitation energies by the state of "non ideality" in dense plasmas were also rejected as the source of ionization or excitation to form the hydrogen plasma.

The emission from a plasma was observed at low temperatures (e.g.  $\approx 10^3 K$ ) from atomic hydrogen and potassium. The release of energy from hydrogen was evidenced by the hydrogen Lyman and Balmer emission which identified the presence of a hydrogen plasma. The persistence of emission following the removal of all of the power to the cell indicates that unknown chemical power source is present. The implication is that a new plasma and light source for the vacuum ultraviolet has been discovered.

The Committee does not understand that the claimed exothermic reaction maintains the rt-plasma in complete accord with the laws of thermodynamics. The ionization fraction of the rt-plasma, like that of glow discharge plasmas, is low, about  $10^{-9}$  corresponding to an electron density of about  $n_e = 2 \times 10^9 cm^{-3}$  determined using a Langmuir probe [54].

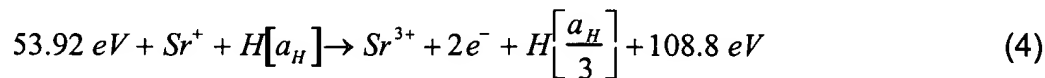
The catalysis reaction of argon is



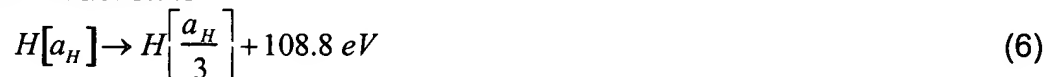
And, the overall reaction is



The catalysis reaction of strontium is



And, the overall reaction is



These reaction are exothermic, and the energy released by forming lower-energy atomic hydrogen with energy levels given by

$$E_n = -\frac{e^2}{n^2 8 \pi \epsilon_0 a_H} = -\frac{13.598 \text{ eV}}{n^2} \quad (7a)$$

$$n = \frac{1}{2}, \frac{1}{3}, \frac{1}{4}, \dots, \frac{1}{p}; \quad p \text{ is an integer; } p \leq 137 \quad (7b)$$

is thermalized to maintain the plasma. The characteristic catalyst emission which confirms the reaction given by Eqs. (1-3) and Eqs. (4-6) are is observed. From the document entitled **"Lower-Energy Hydrogen Experimental Data"**. Confirmation of that the rt-plasma is maintained by the exothermic hydrogen catalysis reaction is provided by

1.) the observation of intense extreme ultraviolet (EUV) emission at low temperatures (e.g.  $\approx 10^3 \text{ K}$ ) from atomic hydrogen and only those atomized elements or gaseous ions which provide a net enthalpy of reaction of approximately  $m \cdot 27.2 \text{ eV}$  via the ionization of  $t$  electrons to a continuum energy level where  $t$  and  $m$  are each an integer (e.g.  $K$  and  $Cs$  atoms and  $Rb^+$  and  $Sr^+$  ions ionize at integer multiples of the potential energy of atomic hydrogen and caused emission; whereas, the chemically similar atoms,  $Na$ ,  $Mg$ , and  $Ba$ , do not ionize at integer multiples of the potential energy of atomic hydrogen and caused no emission) [11-13, 15-16, 20, 24, 27, 32, 39, 42, 46-47, 51-52, 54-55, 57, 72, 81, 89, 91-93],

20.) the observation of continuum state emission of  $Cs^{2+}$  and  $Ar^{2+}$  at  $53.3 \text{ nm}$  and  $45.6 \text{ nm}$ , respectively, with the absence of the other corresponding Rydberg series of lines from these species which confirmed the resonant nonradiative energy transfer of  $27.2 \text{ eV}$  from atomic hydrogen to the either  $Cs$  or  $Ar^+$  catalyst [24, 39, 51, 54-55, 57, 91],

21.) the spectroscopic observation of the predicted hydride ion  $H^-(1/2)$  of hydrogen catalysis by either  $Cs$  or  $Ar^+$  catalyst at  $407 \text{ nm}$  corresponding to its predicted binding energy of  $3.05 \text{ eV}$  [24],

22.) the observation of characteristic emission from  $K^{3+}$  which confirmed the resonant nonradiative energy transfer of  $3 \cdot 27.2 \text{ eV}$  from atomic hydrogen to atomic  $K$  [27, 39, 42, 46, 51, 54-55, 57, 81, 89, 91],

23.) the spectroscopic observation of the predicted  $H^-(1/4)$  ion of hydrogen catalysis by  $K$  catalyst at  $110 \text{ nm}$  corresponding to its predicted binding energy of  $11.2 \text{ eV}$  [81, 42, 27],

24.) the observation of characteristic emission from  $Rb^{2+}$  which confirmed the resonant nonradiative energy transfer of  $27.2\text{ eV}$  from atomic hydrogen to  $Rb^+$  [32, 39, 42, 46, 51, 54-55, 57, 81, 89, 91],

25.) the spectroscopic observation of the predicted  $H^-(1/2)$  ion of hydrogen catalysis by  $Rb^+$  catalyst at  $407\text{ nm}$  corresponding to its predicted binding energy of  $3.05\text{ eV}$  [32],

26.) the observation of  $H^-(1/2)$ , the hydride ion catalyst product of  $K^+ / K^+$  or  $Rb^+$ , at its predicted binding energy of  $3.0468\text{ eV}$  by high resolution visible spectroscopy as a continuum threshold at  $4068.2\text{ \AA}$  and a series of structured peaks separated from the binding energy by an integer multiple of the fine structure of  $H(1/2)$  starting at  $4071\text{ \AA}$  that matched predicted free-free transitions [39, 42, 46, 57, 81, 89, 91],

27.) the observation that the high resolution visible  $K^+ / K^+$  or  $Rb^+ - H_2$  plasma emission spectra in the region of  $3995$  to  $4060\text{ \AA}$  matched the predicted bound-free hyperfine structure lines  $E_{HF}$  of  $H^-(1/2)$  calculated from the electron  $g$  factor as  $E_{HF} = j^2 3.00213 \times 10^{-5} + 3.0563\text{ eV}$  ( $j$  is an integer) for  $j=1$  to  $j=39$  ( $3.0563\text{ eV}$  to  $3.1012\text{ eV}$ —the hydride binding energy peak plus one and five times the spin-pairing energy, respectively) to within a 1 part per  $10^4$  [39, 42, 46, 57, 81, 89, 91],

28.)  $Rb^+$  or  $2K^+$  catalysts formed a plasma having strong VUV emission with a stationary inverted Lyman population with an overpopulation sufficient for lasing, and emission from  $H^-(1/2)$  was observed at  $4071\text{ \AA}$  corresponding to its predicted binding energy of  $3.0468\text{ eV}$  with the fine structure and its predicted bound-free hyperfine structure lines  $E_{HF} = j^2 3.00213 \times 10^{-5} + 3.0563\text{ eV}$  ( $j$  is an integer) that matched for  $j=1$  to  $j=37$  to within a 1 part per  $10^4$  [39, 42, 46, 51, 54, 55, 57, 81, 89, 91],

46.) the observation of the characteristic emission from  $Sr^+$  and  $Sr^{3+}$  that confirmed the resonant nonradiative energy transfer of  $2 \cdot 27.2\text{ eV}$  from atomic hydrogen to  $Sr^+$  [16, 52],

47.) the observation of anomalous plasmas formed with  $Sr$  and  $Ar^+$  catalysts at 1% of the theoretical or prior known voltage requirement with a light output per unit power input up to 8600 times that of the control standard light source [11, 16, 20, 23, 52, 72],



52.) the observation of significant Balmer  $\alpha$  line broadening of 17, 9, 11, 14, and 24 eV from rt-plasmas of incandescently heated hydrogen with  $K^+ / K^+$ ,  $Rb^+$ , cesium, strontium, and strontium with  $Ar^+$  catalysts, respectively, wherein the results could not be explained by Stark or thermal broadening or electric field acceleration of charged species since the measured field of the incandescent heater was extremely weak, 1 V/cm, corresponding to a broadening of much less than 1 eV [39, 42, 46, 51-52, 54-55, 57, 72, 81, 89, 91],

53.) calorimetric measurement of excess power of 20 mW/cc on rt-plasmas formed by heating hydrogen with  $K^+ / K^+$  and  $Ar^+$  as catalysts [39, 81, 89],

54.) the observation of rt-plasmas formed with strontium and argon at 1% of the theoretical or prior known voltage requirement with a light output per unit power input up to 8600 times that of the control standard light source as well as an excess power of 20 mW/cm from rt-plasmas formed by  $Ar^+$  as the catalyst in an incandescent-filament cell [72],

In the case of hydrogen Lyman emission due to plasma formation [11-13, 15-16, 20, 24, 27, 32, 39, 42, 46-47, 51-52, 54-55, 57, 72, 81, 89, 91-93], there is **no** EUV emission in the controls. The formation of a plasma at low temperature with low or no electric field requirement is a first and quite unexpected. The plasma formation only occurs for those systems where catalyst is present. The predicted catalyst emission is observed. The predicted novel hydride ion emission is observed, and novel chemical compounds are formed.

The plasma (rt-plasma) was independently replicated and alternative explanations were eliminated by top plasma physicists [47. H. Conrads, R. Mills, Th. Wrubel, "Emission in the Deep Vacuum Ultraviolet from a Plasma Formed by Incandescently Heating Hydrogen Gas with Trace Amounts of Potassium Carbonate", Plasma Sources Science and Technology, Vol. 12, (2003), pp. 389-395.]. Conrads et al. report:

#### Abstract

A hydrogen plasma with intense extreme ultraviolet and visible emission was generated from low pressure hydrogen gas (0.1-1 mbar) in contact with a hot tungsten filament only when the filament heated a titanium dissociator coated with  $K_2CO_3$  above 750°C. The electric field strength from the filament was about 1 V/cm, two orders of magnitude lower than the starting voltages measured for gas glow discharges. The emission of the  $H_\alpha$  and  $H_\beta$  transitions as well as the  $L_\alpha$  and  $L_\beta$  transitions were recorded and analyzed. The plasma seemed to be far from thermal

equilibrium, and no conventional mechanism was found to explain the formation of a hydrogen plasma by incandescently heating hydrogen gas in the presence of trace amounts of  $K_2CO_3$ . The temporal behavior of the plasma was recorded via hydrogen Balmer alpha line emission when all power into the cell was terminated, and an excessive afterglow duration (2 seconds) was observed. The plasma was found to be dependent on the chemistry of atomic hydrogen with potassium since no plasma formed with  $Na_2CO_3$  replacing  $K_2CO_3$  and the time constant of the emission following the removal of all of the power to the cell matched that of the cooling of the filament and the resulting shift from atomic to molecular hydrogen. Our results indicate that a novel chemical power source is present that forms the energetic hydrogen plasma that is a potential new light source.

The Committee has offered no plausible alternative explanation as to why a very energetic plasma would form with only heating of trace amounts of an inorganic compound and low pressure hydrogen gas. Further, the Committee can not provide a cogent reason for the existence of a hydrogen plasma when there is no power input to the cell, i.e. the afterglow.

Applicant submits that the Committee's explanation violates the laws of thermodynamics and Applicant's explanation fully complies with the laws of thermodynamics. Thus, Applicant once again questions the qualifications of the Committee, especially when compared to Dr. Johannes Conrads, former director of the Institute for Low Temperature Plasma Physics at Ernst Moritz Arndt University in Greifswald, Germany, who conducted the experimental evidence.

For these reasons, the Committee should fully consider the experimental evidence disclosed in attachments 6, 10, 13, 14 and 85.

### **Category (7)**

On page 5 of the Final Office Action, the Committee ignores attachments 3, 11, 12, 15, 70, 85 and 88-90 since they allegedly contain misidentifications of spectral lines. Applicant submits that the spectral lines disclosed on these attachments are accurately identified for the following reasons:

**3. R. Mills, W. Good, R. Shaubach, "Dihydrino Molecule Identification", Fusion Technology, Vol. 25, (1994), pp. 103-119.**

#### **Abstract**

Calorimetry of pulsed current and continuous electrolysis of aqueous potassium carbonate ( $K^+/K^+$  electrocatalytic couple) at a nickel

cathode was performed by Thermacore, Inc. The excess power out of 41 watts exceeded the total input power given by the product of the electrolysis voltage and current by a factor greater than 8. Elemental analysis of the electrolyte and metallurgical analysis of the cathode showed no evidence of chemical reactions. The pH, specific gravity, concentration of  $K_2CO_3$ , and the elemental analysis of the electrolyte sample taken after 42 days of continuous operation were unchanged from that of the values obtained for the electrolyte sample taken before operation. Elemental analysis and scanning electron microscopy of metallurgical samples of the nickel cathode taken before operation and at day 56 of continuous operation were identical indicating that the nickel cathode had not changed chemically or physically. Scintillation counter and photographic film measurements showed that no radiation above background was detected indicating that nuclear reactions did not occur.

The "ash" of the exothermic reaction comprises atoms having electrons of energy below the "ground state," which are predicted to form molecules. The predicted molecules were identified by lack of reactivity with oxygen, by separation from molecular deuterium by cryofiltration, and by mass spectroscopic analysis. The combustion of the gases that evolved during the electrolysis of a light water  $K_2CO_3$  electrolyte ( $K^+/K^+$  electrocatalytic couple) with a nickel cathode was incomplete. The mass spectroscopic analysis (by Dr. David Parees of Air Products & Chemicals, Inc.) of the  $m/e = 2$  peak of the combusted gas demonstrated that the dihydrido molecule,  $H_2(n = 1/2)$ , has a higher ionization energy than  $H_2$ .

Calorimetry of pulsed current and continuous electrolysis of aqueous potassium carbonate ( $K^+/K^+$  electrocatalytic couple) at a nickel cathode was performed in single-cell dewar calorimetry cells by HydroCatalysis Power Corporation. Excess power out exceeded input power by a factor greater than 16. No excess heat was observed when the electrolyte was changed from potassium carbonate to the control sodium carbonate. The faraday efficiency was measured volumetrically to be 100%.

The mass spectrum of hydrogen is known to be  $m/e=2$  as reported. There is no misidentification of spectral lines. It was extraordinary that the ionization energy of the hydrogen species  $H_2(n = 1/2)$  was shown to be higher than that of  $H_2$ .

**11. R. Mills, M. Nansteel, and Y. Lu, "Observation of Extreme Ultraviolet Hydrogen Emission from Incandescently Heated Hydrogen Gas with Strontium that Produced an Anomalous Optically Measured Power Balance", Int. J. Hydrogen Energy, Vol. 26, No. 4, (2001), pp. 309-326.**

**Abstract**

We report the observation of intense extreme ultraviolet (EUV) emission from incandescently heated atomic hydrogen and atomized strontium. It has been reported that intense EUV emission was observed at low temperatures (e.g.  $\approx 10^3 K$ ) from atomic hydrogen and certain atomized elements or certain gaseous ions which ionize at integer multiples of the potential energy of atomic hydrogen,  $27.2 eV$  [1-4]. Strontium ionizes at integer multiples of the potential energy of atomic hydrogen. Typically the emission of extreme ultraviolet light from hydrogen gas is achieved via a discharge at high voltage, a high power inductively coupled plasma, or a plasma created and heated to extreme temperatures by RF coupling (e.g.  $> 10^6 K$ ) with confinement provided by a toroidal magnetic field. The observed plasma formed at low temperatures (e.g.  $\approx 10^3 K$ ) from atomic hydrogen generated at a tungsten filament that heated a titanium dissociator and atomic strontium which was vaporized from the metal by heating. No emission was observed when sodium, magnesium, or barium replaced strontium or when argon replaced hydrogen with strontium. The power balance of a gas cell having atomized hydrogen and strontium was measured by integrating the total light output corrected for spectrometer system response and energy over the visible range. A control cell was identical except that sodium replaced strontium. In this case, 4000 times the power of the strontium cell was required in order to achieve that same optically measured light output power. A plasma formed at a cell voltage of about 250 volts in the cell with hydrogen alone and in the cell with hydrogen and sodium; whereas, a plasma formed in the strontium cell at the extremely low voltage of about 2 volts. The starting and maintenance discharge voltages were two orders of magnitude of that predicted by current theory or observed experimentally.

The EUV spectral lines are the known hydrogen Lyman series. There is no misidentification of spectral lines. It was extraordinary that the Lyman lines were observed under the reported conditions only when atomic hydrogen was present with a claimed catalyst.

**12. R. Mills, T. Onuma, and Y. Lu, "Formation of a Hydrogen Plasma from an Incandescently Heated Hydrogen-Catalyst Gas Mixture with**

**an Anomalous Afterglow Duration", Int. J. Hydrogen Energy, Vol. 26, No. 7, July, (2001), pp. 749-762.**

**Abstract**

We report the generation of a plasma of hydrogen and certain alkali ions as recorded via EUV spectroscopy and the hydrogen Balmer and alkali line emissions in the visible range. Typically a hydrogen plasma is generated and the emission of extreme ultraviolet light from hydrogen gas is achieved via a discharge at high voltage, a high power inductively coupled plasma, or a plasma created and heated to extreme temperatures by RF coupling (e.g.  $> 10^6 K$ ) with confinement provided by a toroidal magnetic field. The observed plasma formed at low temperatures (e.g.  $\approx 10^3 K$ ) from atomic hydrogen generated at a tungsten filament that heated a titanium dissociator and a catalyst comprising one of potassium, rubidium, cesium, and their carbonates and nitrates. These atoms and ions ionize to provide a catalyst with a net enthalpy of reaction of an integer multiple of the potential energy of atomic hydrogen ( $m \cdot 27.2 eV$   $m = \text{integer}$ ) to within 0.17 eV and comprise only a single ionization in the case of a potassium or rubidium ion. Whereas, the chemically similar atoms of sodium and sodium and lithium carbonates and nitrates which do not ionize with these constraints caused no emission. To test the electric dependence of the emission, the weak electric field of about 1 V/cm was set and measured to be zero in  $< 0.5 \times 10^{-6}$  sec. An anomalous afterglow duration of about one to two seconds was recorded in the case of potassium, rubidium, cesium,  $K_2CO_3$ ,  $RbNO_3$ , and  $CsNO_3$ . Hydrogen line or alkali line emission was occurring even though the voltage between the heater wires was set to and measured to be zero. These atoms and ions ionize to provide a catalyst with a net enthalpy of reaction of an integer multiple of the potential energy of atomic hydrogen to within less than the thermal energies at  $\approx 10^3 K$  and comprise only a single ionization in the case of a potassium or rubidium ion. Since the thermal decay time of the filament for dissociation of molecular hydrogen to atomic hydrogen was similar to the anomalous plasma afterglow duration, the emission was determined to be due to a reaction of atomic hydrogen with a catalyst that did not require the presence of an electric field to be functional.

The spectral lines are the known hydrogen Lyman and Balmer series, as well as known alkali lines. There is no misidentification of spectral lines. It was extraordinary that the Lyman lines were observed under the reported conditions only when atomic hydrogen was present with a claimed catalyst.

**15. R. Mills, J. Dong, Y. Lu, "Observation of Extreme Ultraviolet Hydrogen Emission from Incandescently Heated Hydrogen Gas with Certain Catalysts", Int. J. Hydrogen Energy, Vol. 25, (2000), pp. 919-943.**

**Abstract**

Typically the emission of extreme ultraviolet light from hydrogen gas is achieved via a discharge at high voltage, a high power inductively coupled plasma, or a plasma created and heated to extreme temperatures by RF coupling (e.g.  $> 10^6 K$ ) with confinement provided by a toroidal magnetic field. We report the observation of intense EUV emission at low temperatures (e.g.  $< 10^3 K$ ) from atomic hydrogen and certain atomized pure elements or certain gaseous ions which ionize at integer multiples of the potential energy of atomic hydrogen.

The EUV spectral lines are the known hydrogen Lyman series. There is no misidentification of spectral lines. It was extraordinary that the Lyman lines were observed under the reported conditions only when atomic hydrogen was present with a claimed catalyst.

**70. R. Mills, J. He, A. Echezuria, B Dhandapani, P. Ray, "Comparison of Catalysts and Plasma Sources of Vibrational Spectral Emission of Fractional-Rydberg-State Hydrogen Molecular Ion", European Journal of Physics D, submitted.**

**Abstract**

Novel emission lines with energies of  $q \cdot 13.6 eV$  where  $q = 1, 2, 3, 4, 6, 7, 8, 9$ , or 11 were previously observed by extreme ultraviolet (EUV) spectroscopy recorded on microwave discharges of helium with 2% hydrogen [R. L. Mills, P. Ray, "Extreme Ultraviolet Spectroscopy of Helium-Hydrogen Plasma", J. Phys. D, Applied Physics, Vol. 36, (2003), pp. 1535-1542]. These lines matched  $H(1/p)$ , fractional Rydberg states of atomic hydrogen wherein  $n = \frac{1}{2}, \frac{1}{3}, \frac{1}{4}, \dots, \frac{1}{p}$ ; ( $p \leq 137$  is an integer)

replaces the well known parameter  $n = \text{integer}$  in the Rydberg equation for hydrogen excited states. Evidence supports that these states are formed by a resonant nonradiative energy transfer to  $He^+$  acting as a catalyst.  $Ne^+$  and  $Ar^+$  also serve as catalysts to form  $H(1/p)$ ; whereas, krypton, xenon, and their ions serve as controls.  $H(1/p)$  may react with a proton to form  $H_2(1/p)^+$  that has vibrational and rotational energies that are  $p^2$  times those of the species comprising uncatalyzed atomic hydrogen. Extreme ultraviolet (EUV) spectroscopy was recorded on microwave

plasmas of the noble gases mixed with 10% hydrogen in the range 10-65 nm. A series of over twenty peaks was observed with an energy spacing of  $2^2$  times the vibrational energy of  $H_2^+$  that ended on the bond energy of  $H_2(1/4)^+$ . The series that matched the emission corresponding to the reaction  $H(1/4) + H^+ \rightarrow H_2(1/4)^+$  was only observed with microwave or glow discharge plasmas of helium, neon, and argon mixed with hydrogen. The microwave cell consistently produced the most intense lines.

No known species has a series of equal-energy-spaced peaks of the reported energy in this high-energy region. The peaks matched theoretical predictions for the formation of the claimed dihydrino molecular ion.

**85. R. L. Mills, P. Ray, R. M. Mayo, Highly Pumped Inverted Balmer and Lyman Populations, New Journal of Physics, submitted.**

**Abstract**

Comprehensive studies on our brief publication [R. Mills, P. Ray, R. M. Mayo, "The Potential for a Hydrogen Water-Plasma Laser", Applied Physics Letters, Vol. 82, No. 11, (2003), pp. 1679-1681] on the potential of realizing a CW H I laser based on a water vapor plasma are presented. Stationary inverted H Balmer and Lyman populations were observed from a low pressure water-vapor microwave discharge plasma. The ionization and population of excited atomic hydrogen levels was attributed to energy provided by a catalytic resonant energy transfer between hydrogen atoms and oxygen formed in the water plasma. A high hydrogen atom temperature ( $\sim 55$  eV) with a relatively low electron temperature ( $T_e = 2$  eV) exhibited characteristics of cold recombining plasmas. These conditions of a water plasma favored an inverted population in the lower levels. Thus, the catalysis of atomic hydrogen may pump a cw H I laser. From our results, laser oscillations are may be possible from i)  $n = 3, n = 4, n = 5, n = 6, n = 7$  and  $n = 8$  to  $n = 2$ , ii)  $n = 4, n = 5, n = 6$ , and  $n = 7$  to  $n = 3$  and iii)  $n = 5$  and  $n = 6$  to  $n = 4$ . Back illumination with an infrared source showed depopulation of the  $n = 5$  state.

The spectral lines are the known hydrogen Lyman and Balmer series. There is no misidentification of spectral lines. It was extraordinary that inversion was observed under the reported conditions only when atomic hydrogen was present with a claimed catalyst.

**88. R. Mills, J. Sankar, A. Voigt, J. He, P. Ray, B. Dhandapani, "Role of Atomic Hydrogen Density and Energy in Low Power CVD**

**Synthesis of Diamond Films", Thin Solid Films, Vol. 478, (2005), pp. 77-90.**

**Abstract**

Polycrystalline diamond films were synthesized on silicon substrates without diamond seeding by a very low power (~40-80 W) microwave plasma continuous vapor deposition (MPCVD) reaction of a mixture of helium-hydrogen-methane (48.2/48.2/3.6%) or argon-hydrogen-methane (17.5/80/2.5%). But, only diamond-like carbon (DLC) films or no films formed when neon, krypton, or xenon was substituted for helium or argon. The films were characterized by time of flight secondary ion mass spectroscopy (ToF-SIMS), X-ray photoelectron spectroscopy (XPS), Raman spectroscopy, scanning electron microscopy (SEM), and X-ray diffraction (XRD). It is proposed that each of  $He^+$  and  $Ar^+$  served as a catalyst with atomic hydrogen to form an energetic plasma since only plasmas having these ions in the presence of atomic hydrogen showed significantly broadened H  $\alpha$  lines corresponding to an average hydrogen atom temperature of >100 eV as reported previously [R. L. Mills, P. Ray, B. Dhandapani, R. M. Mayo, J. He, "Comparison of Excessive Balmer  $\alpha$  Line Broadening of Glow Discharge and Microwave Hydrogen Plasmas with Certain Catalysts", J. of Applied Physics, (2002), Vol. 92, No. 12, pp. 7008-7022]. It was found that not only the energy, but also the H density uniquely increases in  $He-H_2$  and  $Ar-H_2$  plasmas. Bombardment of the carbon surface by highly energetic hydrogen formed by the catalysis reaction may play a role in the formation of diamond. Then, by this novel pathway, the relevance of the CO tie line is eliminated along with other stringent conditions and complicated and inefficient techniques which limit broad application of the versatility and superiority of diamond thin film technology.

The line widths and intensities was measured on known H Balmer lines. There is no misidentification of spectral lines. The source of the observed, extraordinarily high-energy, fast hydrogen was identified as the claimed energetic catalytic reaction. This paper reports the role of the fast H in diamond formation by energetic bombardment of graphitic carbon.

89. R. Mills, P. C. Ray, M. Nansteel, W. Good, P. Jansson, B. Dhandapani, J. He, "Hydrogen Plasmas Generated Using Certain Group I Catalysts Show Stationary Inverted Lyman Populations and Free-Free and Bound-Free Emission of Lower-Energy State Hydride", Fizika A, submitted.

**Abstract**



$Rb^+$  to  $Rb^{2+}$  and  $2K^+$  to  $K + K^{2+}$  each provide a reaction with a net enthalpy equal to the potential energy of atomic hydrogen. The presence of these gaseous ions with thermally dissociated hydrogen formed a plasma having strong VUV emission with a stationary inverted Lyman population. Significant Balmer  $\alpha$  line broadening of 18 and 12 eV was observed from a rt-plasma of hydrogen with  $KNO_3$ , and  $RbNO_3$ , respectively, compared to 3 eV from a hydrogen microwave plasma. The reaction was exothermic since excess power of about 20 mW/cc was measured by Calvet calorimetry. We propose an energetic catalytic reaction involving a resonance energy transfer between hydrogen atoms and  $Rb^+$  or  $2K^+$  to form a very stable novel hydride ion. Its predicted binding energy of 3.0468 eV with the fine structure was observed at 4071 Å, and its predicted bound-free hyperfine structure lines  $E_{HF} = j^2 3.00213 \times 10^{-5} + 3.0563$  eV ( $j$  is an integer) matched those observed for  $j = 1$  to  $j = 37$  to within a 1 part per  $10^4$ . Characteristic emission from each catalyst was observed. This catalytic reaction may pump a cw HI laser.

All known explanations of the bound-free hyperfine structure lines were considered and eliminated. This is further supported by results reported in the following published articles:

81. R. Mills, P. Ray, B. Dhandapani, W. Good, P. Jansson, M. Nansteel, J. He, A. Voigt, "Spectroscopic and NMR Identification of Novel Hydride Ions in Fractional Quantum Energy States Formed by an Exothermic Reaction of Atomic Hydrogen with Certain Catalysts", *European Physical Journal-Applied Physics*, Vol. 28, (2004), pp. 83-104.
46. R. L. Mills, P. Ray, "Stationary Inverted Lyman Population and a Very Stable Novel Hydride Formed by a Catalytic Reaction of Atomic Hydrogen and Certain Catalysts", *Optical Materials*, Vol. 27, (2004), pp. 181-186.
42. R. L. Mills, P. Ray, "A Comprehensive Study of Spectra of the Bound-Free Hyperfine Levels of Novel Hydride Ion  $H^-(1/2)$ , Hydrogen, Nitrogen, and Air", *Int. J. Hydrogen Energy*, Vol. 28, No. 8, (2003), pp. 825-871.
90. R. L. Mills, P. Ray, M. Nansteel, J. He, X. Chen, A. Voigt, B. Dhandapani, "Characterization of an Energetic Catalyst-Hydrogen

**Plasma Reaction as a Potential New Energy Source", Am. Chem. Soc. Div. Fuel Chem. Prepr., Vol. 48, No. 2, (2003).**

**Abstract**

The possibility that a novel reaction of atomic hydrogen that uses certain catalysts such as  $He^+$ , oxygen, and Group I atoms or ions may be a clean new energy source is supported by spectroscopic, chemical, and thermal data. For example, we report the discovery of new states of hydrogen formed in a catalytic plasmas reaction. The states were identified by the spectroscopic observation of emission lines occurring at energies that are an extension of the Rydberg series to lower states. The novel molecular hydrogen gas product was isolated by liquefaction at liquid nitrogen temperature, and was identified by the observations of novel peaks by cryogenic gas chromatography, a higher ionization energy than  $H_2$  by mass spectroscopy, a unique EUV emission spectrum by optical emission spectroscopy that shifted with deuterium substitution in a region where no hydrogen emission has ever been observed, and upfield shifted NMR peaks at 3.47 and 2.18 ppm compared to that of  $H_2$  at 4.63 ppm. In addition, stationary H populations were formed by using certain catalysts in hydrogen plasmas, and novel processes and hydride products with significant commercial potential were characterized by EUV and visible spectroscopy, NMR, ToF-SIMS, and XPS. Very high (>100 eV) H energies and substantial excess thermal energy were observed.

Multiple spectral studies support the identification of new states of hydrogen of lower energy than the  $n=1$  state. In each case, alternative explanations were considered and eliminated, as given in this paper and the references therein. The results were reported at the 2003 Fall National American Chemical Society Meeting.

For these reasons, the spectral lines in attachments 3, 11, 12, 15, 70, 85 and 88-90 are correctly identified.

**Category (8)**

On page 5 of the Final Office Action, the Committee ignores attachments 29, 30 and 33-51 since they allegedly "contain what applicant claims to be replications of his work, but do not necessarily agree with his conclusions, at best saying the results are 'consistent with' his theory."

Applicant's theory predicted the formation of lower-energy hydrogen before it was known or produced by man. Applicant and independent parties conducted experiments and produced evidence that is "consistent with" Applicant's predictions. When the experimental

evidence is consistent with what was predicted, that evidence proves that the theory is correct. There is no other way to prove that a theory is correct.

No evidence presented by the Committee or others disproves Applicant's theory. The only explanation offered by the Committee to this day is that Quantum Theory predicts that lower-energy is impossible. Since the evidence presented in attachments 29, 30 and 33-51 are "consistent with" Applicant's theory, Applicant's theory must be correct and Quantum Theory wrong.

Furthermore, the inability of Quantum Theory to predict the stability of the hydrogen atom as well as the numerous other inconsistencies and failures of Quantum Theory further demonstrate that Quantum Theory is not the correct description of reality. These issues, and particularly the fact that Quantum Theory is not the correct description of the hydrogen atom, have been addressed in other parts of this Response, as well as in Applicant's previous Responses.

#### **Category (9)**

On page 5 of the Final Office Action, the Committee makes yet another baseless argument, claiming that Applicant's documents "unrelated to the scientific merits of the present invention, and only either generally relate to court cases, or to news stories about the PTO and applicant's related inventions, communications between applicant and the PTO, overviews of applicant's company, conference proceedings, and biographies of applicant's employees. To this category belong the attachments 8, 31, 32, 52-58, 62, 63, 66, 67, 69, 91, 94 and 97."

As an initial matter, Applicant now identifies these documents by reference to Attachments A-R. These attachments were referenced in arguments presented by Applicant in his previous Response that relate directly to issues involving the improper examination of this application and the defective nature of the rejections issued in this case. For the Committee to completely ignore those arguments and to dismiss the attachments related thereto as "news stories" merely demonstrates the bias of the Committee and confirms previous complaints regarding its refusal to properly examine not only the overwhelming evidence supporting Applicant's invention, but also the substantial evidence that undercuts the Committee's rejections.

Applicant's papers clearly teach one skilled in the art how to make, isolate, and extract hydrinos. Thus, the hydrino is no longer "hypothetical" as alleged by the Committee, but is now accepted by the scientific community as demonstrated by the over 60 peer-reviewed articles that Applicant has now made of record.

**Reliance By Examiner Souw On His Own Published Papers  
To Reject Applicant's Claims On Theoretical Grounds Is Blatantly Unfair**

Applicant notes with dismay the citation in the Appendix to Examiner Souw's own technical papers published in the journal *Physica*. The citation of those papers against Applicant's claims on theoretical grounds is inherently unfair for several obvious reasons.

First, the Committee has failed to show that the journals in which those technical papers appear are any more "scientifically qualified" with appropriate review process than the journals that published Applicant's papers. Unless and until the PTO does so, the credibility of Examiner Souw's papers will remain an issue and should not be cited against Applicant. Because, however, the Committee continues to rely on those papers, Applicant's papers must also be considered to be scientifically qualified and to far outweigh the scant scientific evidence provided by Dr. Souw.

Second, for Examiner Souw to cite his own technical papers against Applicant makes it even more unfair, as it limits the Examiner's ability to remain impartial. How can an Examiner be expected to remain unbiased in the face of Applicant's critical arguments when it is his own technical papers that are the subject of those criticisms? The answer is obvious: he can't.

In any case, now that Examiner Souw has relied upon his own scientific research to support the Committee's rejections in this case, Applicant is entitled to know certain details of his background, including his technical education and past work experience.

The Committee attempts, but utterly fails, to rationalize why Dr. Souw should be allowed to cite without scrutiny his own technical papers against Applicant:

Applicant note[s] the involvement of Examiner Bernard Souw in the examination of another of his applications, and that Examiner Souw had previously worked for Brookhaven National Labs. Two things are thus pointed out. First, examiners are allowed, and even encouraged, to

consult other examiners on matters of science. Dr. Souw is the author of the attached Appendix. While originally written for Serial No. 09/513,768, the Appendix is considered relevant to the present application for reasons stated below. Second, the employment history of examiners, including those acting in a consulting role, is irrelevant to the examination thereof, except where there is a genuine conflict of interest. [Office Action at pp. 4-5]

The first point—that the PTO generally encourages consultation with other Examiners—is not even in dispute and, therefore, is irrelevant. The point of Applicant's objections to the consultation of Dr. Souw in this specific case is the obvious conflict created by his citing papers he authored. It cannot be seriously argued that Dr. Souw can be unbiased in critically analyzing his own work.

The PTO's second point—that the employment history of Examiners is only relevant when there is a genuine conflict of interest—merely argues in Applicant's favor. It is precisely because Applicant has demonstrated a genuine conflict of interest with regard to Dr. Souw's citation to his own work, undertaken at a government-funded laboratory involved in competitive research sanctioned by the APS, that makes his employment history relevant to the examination of this application. Thus, Dr. Souw's employment history, including his connection to any APS activities during that employment, is highly relevant. Furthermore, as explained above, the Committee's refusal to provide this relevant information was what led Applicant to conduct his own investigation into this matter. This investigation has uncovered what the Committee refers to as "genuine conflicts of interest" on the part of Examiner Souw based on his outside business activities, which information Applicant feared was being withheld.

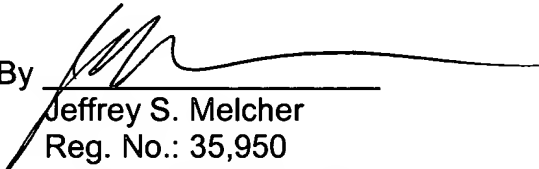
Regarding the substance of the arguments presented in the Appendix, it appears that the Committee once again prefers engaging in a theoretical debate to the exclusion of Applicant's experimental evidence, pitting its favored quantum theory, with all of its far-fetched and disproved predictions, against Applicant's theory of classical quantum mechanics that correctly predicts the formation of lower-energy hydrogen. Nevertheless, Applicant provides a complete and detailed response to each theoretical point raised in Examiner Souw's Appendix and requests that the Committee fully consider that response. [See Attachment, "Response to Souw Appendix".] Applicant

further requests that the Committee: (1) properly consider all of Applicant's experimental evidence appearing in his peer-reviewed journal articles—much of it generated by independent third parties—rather than just a small, isolated portion of that evidence; and (2) follow its own admitted standard by giving those articles “the credibility that peer-reviewed articles have.”

**Conclusion**

For the foregoing reasons, Applicant respectfully submits that the subject application fully satisfies the legal requirements of 35 U.S.C. §§ 101 and 112, first paragraph, and is therefore in condition for allowance. A Notice to that affect is earnestly solicited.

Respectfully submitted,  
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## Journal and Book Publications

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111. R. Mills, J. He, Z. Chang, W. Good, Y. Lu, B. Dhandapani, "Catalysis of Atomic Hydrogen to Novel Hydrogen Species  $H^-(1/4)$  and  $H_2(1/4)$  as a New Power Source", Thermochemica Acta, submitted.
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### **Test Reports**

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### **Upcoming Conference Presentations**

### **Prior Conference Presentations**

56. R. Mills, "The Grand Unified Theory of Classical Quantum Mechanics Workshop", at the University of Milano di Politecnico, Milan, Italy, Sponsored by the POLITECNICO Foundation, March 3, 2005.
55. R. Mills, "The Hydrino: Lower-level States of the Hydrogen Atom which Have Remarkable Consequences". Invited Evening Lecture at the 17th Symposium of Plasma Physics and Radiation Technology, sponsored by the Netherlands' Physical Society Section Plasma and Gas Discharge Physics and Research School Center for Plasma Physics and Radiation Technology, Lunteren, Netherlands, March 1-2, 2005.
54. R. Mills, "The Grand Unified Theory of Classical Quantum Mechanics Workshop", at the University of Eindhoven, Netherlands, February 28, 2005.
53. R. L. Mills, Y. Lu, M. Nansteel, J. He, A. Voigt, W. Good, B. Dhandapani, "Energetic Catalyst-Hydrogen Plasma Reaction as a Potential New Energy Source", Division of Fuel Chemistry, Session: Advances in Hydrogen Energy, 228th American Chemical Society National Meeting, August 22-26, 2004, Philadelphia, PA.
52. R. L. Mills, BlackLight Power A New Energy Source, Volta Institute, June 25, 2004, Como, Italy.
51. R. L. Mills, Y. Lu, M. Nansteel, J. He, A. Voigt, B. Dhandapani, "Energetic Catalyst-Hydrogen Plasma Reaction as a Potential New Energy Source", Division of Fuel Chemistry, Session: Chemistry of Solid, Liquid, and Gaseous Fuels, 227th American Chemical Society National Meeting, March 28-April 1, 2004, Anaheim, CA.
50. R. L. Mills, P. Ray, M. Nansteel, J. He, X. Chen, A. Voigt, B. Dhandapani, "Energetic Catalyst-Hydrogen Plasma Reaction as a Potential New Energy Source," (Division of Industrial and Engineering Chemistry Symposium), September 9, 2003, 226<sup>th</sup> American Chemical Society National Meeting, (Sept. 7-11, 2003), New York, NY.
49. B. Dhandapani, R. Mills, "Novel Liquid-Nitrogen-Condensable Molecular Hydrogen Gas" (Physical Chemistry Session) , Wednesday, June 11, 2003, 36<sup>th</sup> Middle Atlantic Regional Meeting of American Chemical Society, (June 8-11, 2003), Princeton University, Princeton, NJ.
48. P. Ray, R. Mills, "Extreme Ultraviolet Spectroscopy of Helium-Hydrogen Plasma" (Physical Chemistry Session) , Wednesday, June 11, 2003, 36<sup>th</sup> Middle Atlantic Regional

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47. R. Mills, "Novel Catalytic Reaction Of Hydrogen as a Potential New Energy Source" (Catalysis Session), Tuesday, June 10, 2003, 36<sup>th</sup> Middle Atlantic Regional Meeting of American Chemical Society, (June 8–11, 2003), Princeton University, Princeton, NJ.
  46. J. He, R. Mills, "TOF-SIMS and XPS Studies of Highly Stable Silicon Hydride Films" (Inorganic/Solid State Session), Monday, June 9, 2003, 36<sup>th</sup> Middle Atlantic Regional Meeting of American Chemical Society, (June 8–11, 2003), Princeton University, Princeton, NJ.
  45. B. Dhandapani, R. Mills, "Low Power MPCVD Synthesis and Characterization of Diamond Films on Silicon Substrates" (Inorganic/Solid State Session) , Monday, June 9, 2003, 36<sup>th</sup> Middle Atlantic Regional Meeting of American Chemical Society, (June 8–11, 2003), Princeton University, Princeton, NJ.
  44. X. Chen, R. Mills, "Calorimetric Study of Heat Generation by Catalytic Reaction of Atomic Hydrogen in Resonant Transfer Plasmas" (Fuel Cells Session) , Monday, June 9, 2003, 36<sup>th</sup> Middle Atlantic Regional Meeting of American Chemical Society, (June 8–11, 2003), Princeton University, Princeton, NJ.
  43. R. L. Mills, "Novel Catalytic Reaction of Hydrogen as a Potential New Energy Source", Division of Industrial and Engineering Chemistry, "Green Chemistry in the Design of Alternative Energy Strategies", symposium, Oral Presentation, 225<sup>th</sup> ACS National Meeting, (March 23-27, 2003), New Orleans, LA.
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16. R. Mills, B. Dhandapani, N. Greenig, J. He, J. Dong, Y. Lu, and H. Conrads, "Formation of an Energetic Plasma and Novel Hydrides from Incandescently Heated Hydrogen Gas with Certain Catalysts", August National ACS Meeting (220th ACS National Meeting, Washington, DC, (August 20-24, 2000)).
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11. R. Mills, "Novel Hydride Compound", 219 th National ACS Meeting, San Francisco, California, (March 26-30, 2000).
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3. R. Mills, B. Dhandapani, N. Greenig, J. He, "Synthesis and Characterization of Potassium Iodo Hydride", 1999 Pacific Conference on Chemistry and Spectroscopy and the 35th ACS Western Regional Meeting, Ontario Convention Center, California, (October 6-8, 1999).
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1. R. Mills, "Excess Heat Production by the Electrolysis of an Aqueous Potassium Carbonate Electrolyte", August 1991 meeting of the American Chemical Society, NY, NY.



## ATTACHMENT

**Response to Bernard Souw Appendix attached to  
the January 26, 2005 Final Office Action in U.S. 09/501,622**

For the convenience of the Secret Committee, this Response will retain the references numbers and validation points consistent with those given in Applicant's main Response to which this is attached.

Applicant has published over 50 articles in reputable, peer-reviewed journals and has submitted over 50 additional articles which Applicant is confident will eventually be published materially in their present form. Studies that experimentally confirm a novel reaction of atomic hydrogen which produces hydrogen in fractional quantum states that are at lower energies than the traditional "ground" ( $n = 1$ ) state, a chemically generated or assisted plasma (rt-plasma), and produces novel hydride compounds include extreme ultraviolet (EUV) spectroscopy,<sup>1</sup> characteristic emission from catalysis and the hydride ion products<sup>2</sup>, lower-energy hydrogen emission<sup>3</sup>, plasma formation<sup>4</sup>, Balmer  $\alpha$  line broadening<sup>5</sup>, population inversion of hydrogen lines<sup>6</sup>, elevated electron temperature<sup>7</sup>, anomalous plasma afterglow duration<sup>8</sup>, power generation<sup>9</sup>, excessive light emission<sup>10</sup>, and analysis of chemical compounds<sup>11</sup>. Direct plasma to electric power conversion is possible<sup>12</sup>. Exemplary studies include:

1.) the observation of intense extreme ultraviolet (EUV) emission at low temperatures (e.g.  $\approx 10^3$  K) from atomic hydrogen and only those atomized elements or gaseous ions which provide a net enthalpy of reaction of approximately  $m \cdot 27.2$  eV via the ionization of  $t$  electrons to a continuum energy level where  $t$  and  $m$  are each an integer (e.g. K and Cs atoms and  $Rb^+$  and  $Sr^+$  ions ionize at integer multiples of the potential energy of atomic hydrogen and caused

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<sup>1</sup> Reference Nos. 11-16, 20, 24, 27-29, 31-36, 39, 42-43, 46-47, 50-52, 54-55, 57, 59, 63, 65-68, 70-76, 78-79, 81, 83, 85, 86, 89, 91-93, 95-96, 98, 101, 104.

<sup>2</sup> Reference Nos. 24, 27, 32, 39, 42, 46, 51-52, 55, 57, 68, 72-73, 81, 89, 91

<sup>3</sup> Reference Nos. 14, 28-29, 33-36, 50, 63, 67, 70-71, 73, 75-76, 78-79, 86-87, 90, 92, 93, 98, 101, 104

<sup>4</sup> Reference Nos. 11-13, 15-16, 20, 24, 27, 32, 39, 42, 46-47, 51-52, 54-55, 57, 72, 81, 89, 91-93

<sup>5</sup> Reference Nos. 16, 20, 30, 33-37, 39, 42-43, 49, 51-52, 54-55, 57, 63-65, 68-69, 71-74, 81-85, 88-89, 91, 92, 93, 95-97, 105

<sup>6</sup> Reference Nos. 39, 46, 51, 54, 55, 57, 59, 65-66, 68, 74, 83, 85, 89, 91

<sup>7</sup> Reference Nos. 34-37, 43, 49, 63, 67, 73

<sup>8</sup> Reference Nos. 12-13, 47, 81

<sup>9</sup> Reference Nos. 30-31, 33, 35-36, 39, 43, 50, 63, 71-73, 76-77, 81, 84, 89, 92, 93, 98, 101, 104

<sup>10</sup> Reference Nos. 11, 16, 20, 23, 31, 37, 43, 52, 72

<sup>11</sup> Reference Nos. 6-10, 19, 25, 38, 41, 44-45, 60-62, 64, 69, 75, 81-82, 87-88, 90, 92, 93, 94, 98, 100, 101, 104

<sup>12</sup> Reference Nos. 18, 26, 40, 48, 56, 68

emission; whereas, the chemically similar atoms, *Na*, *Mg*, and *Ba*, do not ionize at integer multiples of the potential energy of atomic hydrogen and caused no emission)<sup>13</sup>,

2.) the observation of novel EUV emission lines from microwave and glow discharges of helium with 2% hydrogen with energies of  $q \cdot 13.6 \text{ eV}$  where  $q = 1, 2, 3, 4, 6, 7, 8, 9, 11, 12$  or these lines inelastically scattered by helium atoms in the excitation of  $He(1s^2)$  to  $He(1s^1 2p^1)$  that were identified as hydrogen transitions to electronic energy levels below the "ground" state corresponding to fractional quantum numbers<sup>14</sup>,

3.) the observation of novel EUV emission lines from microwave and glow discharges of helium with 2% hydrogen at 44.2 nm and 40.5 nm with energies of

$$q \cdot 13.6 + \left( \frac{1}{n_f^2} - \frac{1}{n_i^2} \right) \cdot 13.6 \text{ eV} \text{ where } q = 2 \text{ and } n_f = 2, 4 \text{ } n_i = \infty \text{ that corresponded to}$$

multipole coupling to give two-photon emission from a continuum excited state atom and an atom undergoing fractional Rydberg state transition<sup>15</sup>,

4.) the identification of transitions of atomic hydrogen to lower energy levels corresponding to lower-energy hydrogen atoms in the extreme ultraviolet emission spectrum from interstellar medium and the sun<sup>16</sup>,

5.) the observation that the novel EUV series of lines with energies of  $q \cdot 13.6 \text{ eV}$  was observed with an Evenson microwave cell, only the peak corresponding to  $q = 2$  was observed with an RF cell, and none of the peaks were observed with a glow discharge cell<sup>17</sup>,

6.) the observation that in a comparison of Evenson, McCarroll, cylindrical, and Beenakker microwave cavity plasmas, the novel EUV series of lines with energies of  $q \cdot 13.6 \text{ eV}$  was only observed for Evenson-cavity helium-hydrogen plasmas<sup>18</sup>,

7.) the EUV spectroscopic observation of lines for a hydrogen-*K* catalyst plasma by the Institut für Niedertemperatur-Plasmaphysik e.V. that could be assigned to transitions of atomic

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<sup>13</sup> Reference Nos. 11-13, 15-16, 20, 24, 27, 32, 39, 42, 46-47, 51-52, 54-55, 57, 72, 81, 89, 91-93

<sup>14</sup> Reference Nos. 28, 33-36, 50, 63, 67, 71, 73, 75-76, 78, 86-87, 90

<sup>15</sup> Reference Nos. 36, 71, 73

<sup>16</sup> Reference Nos. 1, 5, 17, 28-29

<sup>17</sup> Reference Nos. 71, 73

<sup>18</sup> Reference No. 76

hydrogen to lower energy levels corresponding to fractional principal quantum numbers and the emission from the excitation of the corresponding hydride ions<sup>19</sup>,

8.) the recent analysis of mobility and spectroscopy data of individual electrons in liquid helium which shows direct experimental confirmation that electrons may have fractional principal quantum energy levels<sup>20</sup>,

9.) the observation of novel EUV emission lines from microwave discharges of argon or helium with 10% hydrogen that matched those predicted for the reaction  $H(1/4) + H^+ \rightarrow H_2(1/4)^+$  having an energy spacing of  $2^2$  times the transition-state vibrational energy of  $H_2^+$  with the series ending on the bond energy of  $H_2(1/4)^+$ <sup>21</sup>,

10.) the result that the novel vibrational series for the reaction  $H(1/4) + H^+ \rightarrow H_2(1/4)^+$  was only observed for catalyst plasmas of helium, neon, and argon mixed with hydrogen, but not with noncatalyst xenon or krypton mixed plasmas<sup>22</sup>,

11.) the observation that based on the intensities of the peaks, the catalyst and the plasma source dependence of the reaction rate to form  $H_2(1/4)^+$  is  $Ar^+ > He^+ > Ne^+$  and microwave > glow discharge >> RF, respectively<sup>23</sup>,

12.) the observation that the microwave plasma source dependence of the reaction rate to form  $H_2(1/4)^+$  is Evenson microwave > McCarroll, cylindrical, Beenakker<sup>24</sup>,

13.) the observation of rotational lines in the 145-300 nm region from atmospheric pressure 15 keV electron-beam excited argon-hydrogen plasmas where the unprecedented energy spacing of  $4^2$  times that of hydrogen established the internuclear distance as 1/4 that of  $H_2$  and identified  $H_2(1/4)^+$ <sup>25</sup>,

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<sup>19</sup> Reference No. 14

<sup>20</sup> Reference Nos. 17, 53

<sup>21</sup> Reference Nos. 29, 70, 73, 79, 92, 93, 98, 101, 104

<sup>22</sup> Reference Nos. 29, 70, 73, 79, 92, 93, 101

<sup>23</sup> Reference No. 70

<sup>24</sup> Reference No. 79

<sup>25</sup> Reference Nos. 98, 101, 104

14.) the observation of a series of vibration-rotational bands in the 60-67 nm region, a high-energy region for which vibration-rotational spectra are ordinarily unknown, emitted from low-pressure helium-hydrogen (99/1%) microwave plasmas that matched the predicted energy spacing of the vibrational energy of  $H_2$  about the bond energy of  $H_2(1/2)$  corresponding to the reaction  $2H(1/2) \rightarrow H_2(1/2)$ <sup>26</sup>,

15.) the observation of EUV plasma emission spectra in the region 60 nm to 100 nm that matched the predicted emission lines  $E_{D_{H_2}}$  due to the reaction  $2H(1/2) \rightarrow H_2(1/2)$  with vibronic coupling at energies of  $E_{D+vib} = 17.913 \pm \left(\frac{\nu^*}{3}\right) 0.515902 \text{ eV}$  to longer wavelengths for  $\nu^* = 2$  to  $\nu^* = 32$  and to shorter wavelengths for  $\nu^* = 1$  to  $\nu^* = 16$  to within the spectrometer resolution of about  $\pm 0.05\%$ <sup>27</sup>,

16.) the observation that in addition to members of the series of novel emission lines with energies of  $q \cdot 13.6 \text{ eV}$  or  $E_{D+vib} = 17.913 \pm \left(\frac{\nu^*}{3}\right) 0.515902 \text{ eV}$  an additional intense peak was observed from a scaled-up Evenson cell at 41.6 nm with an energy of 29.81 eV that matched  $q \cdot 13.6 \text{ eV}$  with  $q = 4$  less 24.58741 eV corresponding to inelastic scattering of these photons by helium atoms due to ionization of  $He$  to  $He^+$ <sup>28</sup>,

17.) the observation that in a comparison of Evenson, McCarroll, cylindrical, and Beenakker microwave cavity plasmas, the novel series of spectral lines due to the reaction  $2H(1/2) \rightarrow H_2(1/2)$  with vibronic coupling at energies of  $E_{D+vib} = 17.913 \pm \left(\frac{\nu^*}{3}\right) 0.515902 \text{ eV}$  was only observed for Evenson-cavity helium-hydrogen and neon-hydrogen plasmas<sup>29</sup>,

18.) the observation by gas chromatography that hydrogen was consumed by the helium-hydrogen plasmas which showed the novel EUV series of lines with energies of  $q \cdot 13.6 \text{ eV}$ , the novel series of spectral lines due to the reaction  $2H(1/2) \rightarrow H_2(1/2)$  with vibronic coupling at energies of  $E_{D+vib} = 17.913 \pm \left(\frac{\nu^*}{3}\right) 0.515902 \text{ eV}$ , extraordinary H Balmer line broadening corresponding to 180 - 210 eV, and excess power of 21.9 W in 3 cm<sup>3</sup><sup>30</sup>,

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<sup>26</sup> Reference No. 99

<sup>27</sup> Reference Nos. 50, 75-76, 78, 86-87, 90

<sup>28</sup> Reference No. 86

<sup>29</sup> Reference No. 76

<sup>30</sup> Reference No. 76

19.) the observation of the dominant  $He^+$  emission and an intensification of the plasma emission observed when  $He^+$  was present with atomic hydrogen demonstrated the role of  $He^+$  as a catalyst<sup>31</sup>,

20.) the observation of continuum state emission of  $Cs^{2+}$  and  $Ar^{2+}$  at 53.3 nm and 45.6 nm, respectively, with the absence of the other corresponding Rydberg series of lines from these species which confirmed the resonant nonradiative energy transfer of 27.2 eV from atomic hydrogen to the either Cs or  $Ar^+$  catalyst<sup>32</sup>,

21.) the spectroscopic observation of the predicted hydride ion  $H^-(1/2)$  of hydrogen catalysis by either Cs or  $Ar^+$  catalyst at 407 nm corresponding to its predicted binding energy of 3.05 eV<sup>33</sup>,

22.) the observation of characteristic emission from  $K^{3+}$  which confirmed the resonant nonradiative energy transfer of 3 · 27.2 eV from atomic hydrogen to atomic  $K^{3+}$ ,

23.) the spectroscopic observation of the predicted  $H^-(1/4)$  ion of hydrogen catalysis by K catalyst at 110 nm corresponding to its predicted binding energy of 11.2 eV<sup>35</sup>,

24.) the observation of characteristic emission from  $Rb^{2+}$  which confirmed the resonant nonradiative energy transfer of 27.2 eV from atomic hydrogen to  $Rb^{3+}$ ,

25.) the spectroscopic observation of the predicted  $H^-(1/2)$  ion of hydrogen catalysis by  $Rb^+$  catalyst at 407 nm corresponding to its predicted binding energy of 3.05 eV<sup>37</sup>,

26.) the observation of  $H^-(1/2)$ , the hydride ion catalyst product of  $K^+ / K^+$  or  $Rb^+$ , at its predicted binding energy of 3.0468 eV by high resolution visible spectroscopy as a continuum threshold at 4068.2 Å and a series of structured peaks separated from the binding energy by an

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<sup>31</sup> Reference Nos. 36, 73

<sup>32</sup> Reference Nos. 24, 39, 51, 54-55, 57, 91

<sup>33</sup> Reference No. 24

<sup>34</sup> Reference Nos. 27, 39, 42, 46, 51, 54-55, 57, 81, 89, 91

<sup>35</sup> Reference Nos. 81, 42, 27

<sup>36</sup> Reference Nos. 32, 39, 42, 46, 51, 54-55, 57, 81, 89, 91

<sup>37</sup> Reference No. 32

integer multiple of the fine structure of  $H(1/2)$  starting at 4071 Å that matched predicted free-free transitions<sup>38</sup>,

27.) the observation that the high resolution visible  $K^+ / K^+$  or  $Rb^+ - H_2$  plasma emission spectra in the region of 3995 to 4060 Å matched the predicted bound-free hyperfine structure lines  $E_{HF}$  of  $H(1/2)$  calculated from the electron  $g$  factor as

$E_{HF} = j^2 3.00213 \times 10^{-5} + 3.0563 \text{ eV}$  ( $j$  is an integer) for  $j = 1$  to  $j = 39$  (3.0563 eV to 3.1012 eV—the hydride binding energy peak plus one and five times the spin-pairing energy, respectively) to within a 1 part per  $10^{439}$ ,

28.)  $Rb^+$  or  $2K^+$  catalysts formed a plasma having strong VUV emission with a stationary inverted Lyman population with an overpopulation sufficient for lasing, and emission from  $H^-(1/2)$  was observed at 4071 Å corresponding to its predicted binding energy of 3.0468 eV with the fine structure and its predicted bound-free hyperfine structure lines  $E_{HF} = j^2 3.00213 \times 10^{-5} + 3.0563 \text{ eV}$  ( $j$  is an integer) that matched for  $j = 1$  to  $j = 37$  to within a 1 part per  $10^{440}$ ,

29.) the observation of stationary inverted H Balmer and Lyman populations from a low pressure water-vapor microwave discharge plasma with an overpopulation sufficient for lasing at wavelengths over a wide range from micron to blue wherein molecular oxygen served as the catalyst as supported by  $O^{2+}$  emission and H Balmer line broadening of 55 eV compared to 1 eV for hydrogen alone<sup>41</sup>,

30.) the observation of H Balmer line broadening of 55 eV compared to 1 eV for hydrogen alone at distances up to 5 cm from the coupler<sup>42</sup>,

31.) the observation that with a microwave input power of  $9 \text{ W} \cdot \text{cm}^{-3}$ , a collisional radiative model showed that the hydrogen excited state population distribution was consistent with an  $n = 1 \rightarrow 5, 6$  pumping power of an unprecedented  $200 \text{ W} \cdot \text{cm}^{-3}$  permissive of gas laser efficiencies orders of magnitude those of conventional visible gas lasers and direct generation of

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<sup>38</sup> Reference Nos. 39, 42, 46, 57, 81, 89, 91

<sup>39</sup> Reference Nos. 39, 42, 46, 57, 81, 89, 91

<sup>40</sup> Reference Nos. 39, 42, 46, 51, 54, 55, 57, 81, 89, 91

<sup>41</sup> Reference Nos. 59, 65-66, 68, 74, 83, 85

<sup>42</sup> Reference No. 74

electrical power using photovoltaic conversion of the spontaneous or stimulated water vapor plasma emission<sup>43</sup>;

32.) the observation of stimulation of the stationary inverted H Balmer population from a low pressure water-vapor microwave discharge plasma by back illumination with an infrared source that showed depopulation of the  $n = 5$  state<sup>44</sup>,

33.) the observation of stationary inverted H Balmer and Lyman populations from a low pressure water-vapor microwave discharge plasma with an overpopulation sufficient for lasing was observed for Evenson microwave plasmas, but not for RF or discharge plasmas<sup>45</sup>,

34.) the observation of stationary inverted H Balmer and Lyman populations from a low pressure water-vapor microwave discharge plasma with an overpopulation sufficient for lasing that was dependent on the microwave plasma source with the highest inversion from Evenson microwave plasmas<sup>46</sup>,

35.) the observation of stationary inverted H Balmer and Lyman populations from a low pressure water-vapor microwave discharge plasma with an overpopulation sufficient for lasing that was dependent on the pressure of the Evenson microwave plasma<sup>47</sup>,

36.) the observation of stationary inverted H Balmer populations from a low pressure water-vapor microwave discharge plasma with an overpopulation sufficient for lasing at distances up to 5 cm from the coupler<sup>48</sup>,

37.) the observation that the requirement for the natural hydrogen-oxygen stoichiometry of the Evenson water plasma was stringent in that a deviation by over 2% excess of either gas caused a reversal of the H inversion in water vapor plasmas<sup>49</sup>,

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<sup>43</sup> Reference Nos. 68, 83, 85

<sup>44</sup> Reference Nos. 59, 65, 68, 85

<sup>45</sup> Reference Nos. 59, 65-66, 68, 73, 83, 85

<sup>46</sup> Reference No. 83

<sup>47</sup> Reference Nos. 59, 68, 73, 83, 85

<sup>48</sup> Reference No. 74

<sup>49</sup> Reference Nos. 59, 68, 83, 85

38.) the observation of a typical slow H population for a water-vapor plasma maintained in a GEC-type cell that was independent of time, and a new phenomenon, an extraordinary fast population that increased from zero to a significant portion of the Balmer  $\alpha$  emission with time under no-flow conditions wherein the peak width and energy increased with time up to a 0.7 nm half-width corresponding to an average hydrogen atom energy of 200 eV<sup>50</sup>,

39.) the observation of a substantial fast H population (~20% at 40 eV) for a water-vapor plasmas maintained in a GEC-type cell that was independent of position including regions where the electric field was orders of magnitude too low to explain the extraordinarily high Doppler energies<sup>51</sup>,

40.) the observation of fast H population (40-50 eV) for  $He/H_2$  (95/5%),  $Ar/H_2$  (95/5%), and  $H_2$  plasmas maintained in a GEC-type cell that was independent of position including regions where the electric field was orders of magnitude too low to explain the extraordinarily high Doppler energies<sup>52</sup>,

41.) the observation by the Institut für Niedertemperatur-Plasmaphysik e.V. of an anomalous plasma and plasma afterglow duration formed with hydrogen-potassium mixtures<sup>53</sup>,

42.) the observation of anomalous afterglow durations of plasmas formed by catalysts providing a net enthalpy of reaction within thermal energies of  $m \cdot 27.28 \text{ eV}$ <sup>54</sup>,

43.) the formation of a chemically generated hydrogen plasma with the observation of Lyman series in the EUV that represents an energy release about 10 times that of hydrogen combustion which is greater than that of any possible known chemical reaction<sup>55</sup>,

44.) the observation of line emission by the Institut für Niedertemperatur-Plasmaphysik e.V. with a 4° grazing incidence EUV spectrometer that was 100 times more energetic than the combustion of hydrogen<sup>56</sup>,

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<sup>50</sup> Reference No. 95

<sup>51</sup> Reference No. 96

<sup>52</sup> Reference Nos. 92, 93, 97, 105

<sup>53</sup> Reference Nos. 13, 47, 81

<sup>54</sup> Reference Nos. 12, 13, 47, 81

<sup>55</sup> Reference Nos. 11-13, 15-16, 20, 24, 27, 32, 39, 42, 46-47, 51-52, 54-55, 57, 72, 81, 89, 91

<sup>56</sup> Reference No. 14



45.) the excessive increase in the Lyman emission upon the addition of helium or argon catalyst to a hydrogen plasma<sup>57</sup>,

46.) the observation of the characteristic emission from  $Sr^+$  and  $Sr^{3+}$  that confirmed the resonant nonradiative energy transfer of  $2 \cdot 27.2 \text{ eV}$  from atomic hydrogen to  $Sr^+$ <sup>58</sup>,

47.) the observation of anomalous plasmas formed with  $Sr$  and  $Ar^+$  catalysts at 1% of the theoretical or prior known voltage requirement with a light output per unit power input up to 8600 times that of the control standard light source<sup>59</sup>,

48.) the observation that the optically measured output power of gas cells for power supplied to the glow discharge increased by over two orders of magnitude depending on the presence of less than 1% partial pressure of certain catalysts in hydrogen gas or argon-hydrogen gas mixtures, and an excess thermal balance of 42 W was measured for the 97% argon and 3% hydrogen mixture versus argon plasma alone<sup>60</sup>,

49.) the observation that glow discharge plasmas of the catalyst-hydrogen mixtures of strontium-hydrogen, helium-hydrogen, argon-hydrogen, strontium-helium-hydrogen, and strontium-argon-hydrogen showed significant Balmer  $\alpha$  line broadening corresponding to an average hydrogen atom temperature of 25 - 45 eV; whereas, plasmas of the noncatalyst-hydrogen mixtures of pure hydrogen, krypton-hydrogen, xenon-hydrogen, and magnesium-hydrogen showed no excessive broadening corresponding to an average hydrogen atom temperature of  $\approx 3 \text{ eV}$ <sup>61</sup>,

50.) the observation that microwave helium-hydrogen and argon-hydrogen plasmas having catalyst  $Ar^+$  or  $He^+$  showed extraordinary Balmer  $\alpha$  line broadening due to hydrogen catalysis corresponding to an average hydrogen atom temperature of 110 - 130 eV and 180 - 210 eV, respectively; whereas, plasmas of pure hydrogen, neon-hydrogen, krypton-

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<sup>57</sup> Reference Nos. 20, 31, 37, 43

<sup>58</sup> Reference Nos. 16, 52

<sup>59</sup> Reference Nos. 11, 16, 20, 23, 52, 72

<sup>60</sup> Reference No. 22

<sup>61</sup> Reference Nos. 16, 20, 30, 52, 72

hydrogen, and xenon-hydrogen showed no excessive broadening corresponding to an average hydrogen atom temperature of  $\approx 3 \text{ eV}$ <sup>62</sup>,

51.) the observation that microwave helium-hydrogen and argon-hydrogen plasmas showed average electron temperatures that were high,  $30,500 \pm 5\% \text{ K}$  and  $13,700 \pm 5\% \text{ K}$ , respectively; whereas, the corresponding temperatures of helium and argon alone were only  $7400 \pm 5\% \text{ K}$  and  $5700 \pm 5\% \text{ K}$ , respectively<sup>63</sup>,

52.) the observation of significant Balmer  $\alpha$  line broadening of 17, 9, 11, 14, and 24  $\text{eV}$  from rt-plasmas of incandescently heated hydrogen with  $K^+ / K^+$ ,  $Rb^+$ , cesium, strontium, and strontium with  $Ar^+$  catalysts, respectively, wherein the results could not be explained by Stark or thermal broadening or electric field acceleration of charged species since the measured field of the incandescent heater was extremely weak, 1 V/cm, corresponding to a broadening of much less than 1  $\text{eV}$ <sup>64</sup>,

53.) calorimetric measurement of excess power of 20 mW/cc on rt-plasmas formed by heating hydrogen with  $K^+ / K^+$  and  $Ar^+$  as catalysts<sup>65</sup>,

54.) the observation of rt-plasmas formed with strontium and argon at 1% of the theoretical or prior known voltage requirement with a light output per unit power input up to 8600 times that of the control standard light source as well as an excess power of 20 mW/cm from rt-plasmas formed by  $Ar^+$  as the catalyst in an incandescent-filament cell<sup>66</sup>,

55.) the Calvet calorimetry measurement of an energy balance of over  $-151,000 \text{ kJ/mole } H_2$  with the addition of 3% hydrogen to a plasma of argon having the catalyst  $Ar^+$  compared to the enthalpy of combustion of hydrogen of  $-241.8 \text{ kJ/mole } H_2$ ; whereas, under identical conditions no change in the Calvet voltage was observed when hydrogen was added to a plasma of noncatalyst xenon<sup>67</sup>,

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<sup>62</sup> Reference Nos. 33-37, 43, 49, 60, 63-64, 69, 71, 73-74, 82, 84, 88

<sup>63</sup> Reference Nos. 34-37, 43, 49, 63, 67, 73

<sup>64</sup> Reference Nos. 39, 42, 46, 51-52, 54-55, 57, 72, 81, 89, 91

<sup>65</sup> Reference Nos. 39, 81, 89

<sup>66</sup> Reference No. 72

<sup>67</sup> Reference No. 31

56.) the observation that the power output exceeded the power supplied to hydrogen glow discharge plasmas by 35-184 W depending on the presence of catalysts from helium or argon and less than 1% partial pressure of strontium metal in noble gas-hydrogen mixtures; whereas, the chemically similar noncatalyst krypton had no effect on the power balance<sup>68</sup>,

57.) the observation that with the addition of 3% flowing hydrogen to an argon microwave plasma with a constant input power of 40 W, the gas temperature increased from 400°C to over 750°C; whereas, the 400°C temperature of a xenon plasma run under identical conditions was essentially unchanged with the addition of hydrogen<sup>69</sup>,

58.) observations of power such as that where the addition of 10% hydrogen to a helium microwave plasma maintained with a constant microwave input power of 40 W, the thermal output power was measured to be at least 280 W corresponding to a reactor temperature rise from room temperature to 1200°C within 150 seconds, a power density of  $28 \text{ MW}/\text{m}^3$ , and an energy balance of at least  $-4 \times 10^5 \text{ kJ}/\text{mole } H_2$  compared to the enthalpy of combustion of hydrogen of  $-241.8 \text{ kJ}/\text{mole } H_2$ <sup>70</sup>,

59.) the observation of  $306 \pm 5 \text{ W}$  of excess power generated in  $45 \text{ cm}^3$  by a compound-hollow-cathode-glow discharge of a neon-hydrogen (99.5/0.5%) mixture corresponding to a power density of  $6.8 \text{ MW}/\text{m}^3$  and an energy balance of at least  $-1 \times 10^6 \text{ kJ}/\text{mole } H_2$  compared to the enthalpy of combustion of hydrogen of  $-241.8 \text{ kJ}/\text{mole } H_2$ <sup>71</sup>,

60.) the observation that for an input of 37.7 W, the total plasma power of the neon-hydrogen plasma measured by water bath calorimetry was 60.7 W corresponding to 23.0 W of excess power in  $3 \text{ cm}^3$ <sup>72</sup>,

61.) the observation of intense  $He^+$  emission and a total plasma power of a helium-hydrogen plasma measured by water bath calorimetry of 30.0 W for an input of 8.1 W, corresponding to 21.9 W of excess power in  $3 \text{ cm}^3$  wherein the excess power density and energy balance were high,  $7.3 \text{ W}/\text{cm}^3$  and  $-2.9 \times 10^4 \text{ kJ}/\text{mole } H_2$ , respectively<sup>73</sup>,

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<sup>68</sup> Reference No. 30

<sup>69</sup> Reference No. 43

<sup>70</sup> Reference Nos. 34, 35

<sup>71</sup> Reference Nos. 50, 78

<sup>72</sup> Reference No. 76

<sup>73</sup> Reference Nos. 36, 63, 71, 73

62.) in the comparison of helium-hydrogen plasmas sources, the observation that i.) with an input power of  $24.8 \pm 1$  W, the total plasma power of the Evenson microwave helium-hydrogen plasma measured by water bath calorimetry was  $49.1 \pm 1$  W corresponding to  $24.3 \pm 1$  W of excess power in  $3 \text{ cm}^3$  corresponding to a high excess power density and energy balance of  $8.1 \text{ W/cm}^3$  and over  $-3 \times 10^4 \text{ kJ/mole H}_2$ , respectively, ii.) with an input of 500 W, a total power of 623 W was generated in a  $45 \text{ cm}^3$  compound-hollow-cathode-glow discharge, iii.) less than 10% excess power was observed from inductively coupled RF helium-hydrogen plasmas, and iv.) no measurable heat was observed from MKS/Astex microwave helium-hydrogen plasmas that corresponded to the absence of H Balmer line broadening<sup>74</sup>,

63.) the observation of energy balances of helium-hydrogen microwave plasmas of over 100 times the combustion of hydrogen and power densities greater than  $10 \text{ W/cm}^3$  measured by water bath calorimetry<sup>75</sup>,

64.) at the load matching condition of  $600 \Omega$ , the direct plasmadynamic conversion (PDC) of open circuit voltages of 11.5 V and  $\sim 200$  mW of electrical power with a 0.125 in diameter by 3/4 in long plasmadynamic electrode and a 140 G applied field corresponding to an extracted power density of  $\sim 1.61 \text{ W/cm}^3$  and an efficiency of  $\sim 18.8\%$ <sup>76</sup>,

65.) at the load matching condition of  $250 \Omega$ , the direct plasmadynamic conversion (PDC) of open circuit voltages of 21.8 V and 1.87 W of electrical power with a 0.125 in diameter by 3/4 in long plasmadynamic electrode and a 140 G applied field corresponding to an extracted power density of  $3.6 \text{ W/cm}^3$  and an efficiency of  $42\%$ <sup>77</sup>,

66.) the projection that the generation of electricity using magnetohydrodynamic (MHD) conversion of the plasma particle energy of small to mid-size chemically assisted microwave or glow discharge plasma (ca-plasma) power sources in the range of a few hundred Watts to several 10's of kW for microdistributed commercial applications appears feasible at 50% efficiency or better with a simple compact design<sup>78</sup>,

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<sup>74</sup> Reference Nos. 84, 98, 104

<sup>75</sup> Reference Nos. 34-36, 50, 63, 71, 73, 76-78, 84, 92, 93, 101

<sup>76</sup> Reference No. 48

<sup>77</sup> Reference No. 56

<sup>78</sup> Reference No. 40

67.) the differential scanning calorimetry (DSC) measurement of minimum heats of formation of *KHI* by the catalytic reaction of *K* with atomic hydrogen and *KI* that were over  $-2000 \text{ kJ/mole } H_2$  compared to the enthalpy of combustion of hydrogen of  $-241.8 \text{ kJ/mole } H_2$ <sup>79</sup>,

68.) the isolation of novel hydrogen compounds as products of the reaction of atomic hydrogen with atoms and ions which formed an anomalous plasma as reported in the EUV studies<sup>80</sup>,

69.) the synthesis and identification of a novel diamond-like carbon film terminated with  $CH(1/p)$  ( $H^+ \text{ DLC}$ ) comprising high binding energy hydride ions was synthesized for the first time from solid carbon by a microwave plasma reaction of a mixture of 10-30% hydrogen and 90-70% helium wherein  $He^+$  served as a catalyst with atomic hydrogen to form the highly stable hydride ions and an energetic plasma<sup>81</sup>,

70.) the synthesis of polycrystalline diamond films on silicon substrates without diamond seeding by a very low power microwave plasma reaction of a mixture of helium-hydrogen-methane (48.2/48.2/3.6%) wherein  $He^+$  served as a catalyst with atomic hydrogen to form an energetic plasma with an average hydrogen atom temperature of 180-210 eV versus  $\approx 3 \text{ eV}$  for pure hydrogen and bombardment of the carbon surface by highly energetic hydrogen formed by the catalysis reaction may play a role in the formation of diamond<sup>82</sup>,

71.) the synthesis of polycrystalline diamond films on silicon substrates without diamond seeding by a very low power microwave plasma reaction of a mixture of argon-hydrogen-methane (17.5/80/2.5%) wherein  $Ar^+$  served as a catalyst with atomic hydrogen to form an energetic plasma with an average hydrogen atom temperature of 110-130 eV versus  $\approx 3 \text{ eV}$  for pure hydrogen and bombardment of the carbon surface by highly energetic hydrogen formed by the catalysis reaction may play a role in the formation of diamond<sup>83</sup>,

72.) the identification of a novel highly stable surface coating  $SiH(1/p)$  by time of flight secondary ion mass spectroscopy that showed  $SiH^+$  in the positive spectrum and  $H^-$  dominant in

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<sup>79</sup> Reference No. 25

<sup>80</sup> Reference Nos. 6-10, 19, 25, 38, 41, 44-45, 60-62, 75, 81, 87, 90, 92, 93, 100, 101

<sup>81</sup> Reference No. 60

<sup>82</sup> Reference Nos. 64, 69, 88

<sup>83</sup> Reference Nos. 82, 88

the negative spectrum and by X-ray photoelectron spectroscopy which showed that the  $H$  content of the  $SiH$  coatings was hydride ions,  $H^-(1/4)$ ,  $H^-(1/9)$ , and  $H^-(1/11)$  corresponding to peaks at 11, 43, and 55 eV, respectively, and showed that the surface was remarkably stable to air<sup>84</sup>,

73.) the isolation of novel inorganic hydride compounds such as  $KH KHCO_3$  and  $KH$  following each of the electrolysis and plasma electrolysis of a  $K_2CO_3$  electrolyte which comprised high binding energy hydride ions that were stable in water with their identification by methods such as (i) ToF-SIMS on  $KH KHCO_3$  which showed inorganic hydride clusters  $K[KH KHCO_3]^+$  and a negative ToF-SIMS dominated by hydride ion, (ii) X-ray photoelectron spectroscopy which showed novel peaks corresponding to high binding energy hydride ions, and (iii)  $^1H$  nuclear magnetic resonance spectroscopy which showed upfield shifted peaks corresponding to more diamagnetic, high-binding-energy hydride ions<sup>85</sup>,

74.) the identification of  $LiHCl$  comprising a high binding energy hydride ion by time of flight secondary ion mass spectroscopy which showed a dominant  $H^-$  in the negative ion spectrum, X-ray photoelectron spectroscopy which showed  $H^-(1/4)$  as a new peak at its predicted binding energy of 11 eV,  $^1H$  nuclear magnetic resonance spectroscopy which showed an extraordinary upfield shifted peak of -15.4 ppm corresponding to the novel hydride ion, and powder X-ray diffraction which showed novel peaks<sup>86</sup>,

75.) the identification of novel hydride compounds by a number of analytical methods such as (i) time of flight secondary ion mass spectroscopy which showed a dominant hydride ion in the negative ion spectrum, (ii) X-ray photoelectron spectroscopy which showed novel hydride peaks and significant shifts of the core levels of the primary elements bound to the novel hydride ions, (iii)  $^1H$  nuclear magnetic resonance spectroscopy (NMR) which showed extraordinary upfield chemical shifts compared to the NMR of the corresponding ordinary hydrides, and (iv) thermal decomposition with analysis by gas chromatography, and mass spectroscopy which identified the compounds as hydrides<sup>87</sup>,

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<sup>84</sup> Reference Nos. 45, 61, 100

<sup>85</sup> Reference Nos. 6-7, 9, 38, 41

<sup>86</sup> Reference Nos. 44, 62

<sup>87</sup> Reference Nos. 6-10, 19, 25, 38, 41, 44-45, 60-62, 75, 81, 87, 90, 92, 93, 100

76.) the NMR identification of novel hydride compounds  $MH^*X$  wherein  $M$  is the alkali or alkaline earth metal,  $X$ , is a halide, and  $H^*$  comprises a novel high binding energy hydride ion identified by a large distinct upfield resonance<sup>88</sup>,

77.) the replication of the NMR results of the identification of novel hydride compounds by large distinct upfield resonances at Spectral Data Services, University of Massachusetts Amherst, University of Delaware, Grace Davison, and National Research Council of Canada<sup>89</sup>,

78.) the NMR identification of novel hydride compounds  $MH^*$  and  $MH_2^*$  wherein  $M$  is the alkali or alkaline earth metal and  $H^*$  comprises a novel high binding energy hydride ion identified by a large distinct upfield resonance that proves the hydride ion is different from the hydride ion of the corresponding known compound of the same composition<sup>90</sup>,

79.) the observation that the  $^1H$  MAS NMR spectrum of novel compound  $KH^*Cl$  relative to external tetramethylsilane (TMS) showed a large distinct upfield resonance at -4.4 corresponding to an absolute resonance shift of -35.9 ppm that matched the theoretical prediction of  $p = 4$ , and the novel peak of  $KH^*I$  at -1.5 ppm relative to TMS corresponding to an absolute resonance shift of -33.0 ppm matched the theoretical prediction of  $p = 2$ <sup>91</sup>,

80.) the observation that the predicted catalyst reactions, position of the upfield-shifted NMR peaks, and spectroscopic data for  $H^-(1/2)$  and  $H^-(1/4)$  were found to be in agreement<sup>92</sup>,

81.) the isolation of fraction-principal-quantum-level molecular hydrogen  $H_2(1/p)$  gas by liquefaction using an ultrahigh-vacuum, liquid nitrogen cryotrap, and the observations of novel peaks by cryogenic gas chromatography, a higher ionization energy than  $H_2$  by mass spectroscopy, a substantial change in the EUV emission spectrum with deuterium substitution in a region where no hydrogen emission has ever been observed, and upfield shifted NMR peaks at 0.21, 2.18 and 3.47 ppm compared to that of  $H_2$  at 4.63 ppm<sup>93</sup>,

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<sup>88</sup> Reference Nos. 10, 19, 41, 44, 62, 81

<sup>89</sup> Reference Nos. 19, 81

<sup>90</sup> Reference Nos. 19, 81

<sup>91</sup> Reference No. 81

<sup>92</sup> Reference No. 81

<sup>93</sup> Reference Nos. 75, 87, 90, 92, 93, 94, 101

82.) the observation of  $^1\text{H}$  NMR singlet peaks upfield of  $\text{H}_2$  with a predicted integer spacing of 0.64 ppm at 3.47, 3.02, 2.18, 1.25, 0.85, and 0.22 ppm identified as the consecutive series  $\text{H}_2(1/2)$ ,  $\text{H}_2(1/3)$ ,  $\text{H}_2(1/4)$ ,  $\text{H}_2(1/5)$ ,  $\text{H}_2(1/6)$ , and  $\text{H}_2(1/7)$ , respectively, and  $\text{H}_2(1/10)$  at -1.8 ppm wherein  $\text{H}_2(1/p)$  gas was isolated by liquefaction at liquid nitrogen temperature, by decomposition of compounds found to contain the corresponding hydride ions  $\text{H}^-(1/p)$ , and by permeation through a hollow nickel cathode<sup>94</sup>.

83.) the observation of excess enthalpy from a  $\text{K}_2\text{CO}_3$  electrolytic cell of a factor of two times that of the resistive power dissipation and  $^1\text{H}$  NMR singlet peaks upfield of  $\text{H}_2$  with a predicted integer spacing of 0.64 ppm at 3.49, 2.17, 1.25, 0.86, and 0.21 ppm which matched the consecutive series  $\text{H}_2(1/2)$ ,  $\text{H}_2(1/4)$ ,  $\text{H}_2(1/5)$ ,  $\text{H}_2(1/6)$ , and  $\text{H}_2(1/7)$ , respectively, and a higher ionizing molecular hydrogen recorded on the electrolysis gases collected in a hollow nickel cathode<sup>95</sup>.

The hydrino spectrum has been published in top-tier peer reviewed journals such as:

67. R. L. Mills, P. Ray, "Extreme Ultraviolet Spectroscopy of Helium-Hydrogen Plasma", J. Phys. D, Applied Physics, Vol. 36, (2003), pp. 1535-1542.
50. R. L. Mills, P. Ray, J. Dong, M. Nansteel, B. Dhandapani, J. He, "Spectral Emission of Fractional-Principal-Quantum-Energy-Level Atomic and Molecular Hydrogen", Vibrational Spectroscopy, Vol. 31, No. 2, (2003), pp. 195-213.
33. R. L. Mills, P. Ray, B. Dhandapani, M. Nansteel, X. Chen, J. He, "New Power Source from Fractional Quantum Energy Levels of Atomic Hydrogen that Surpasses Internal Combustion", J. Mol. Struct., Vol. 643, No. 1-3, (2002), pp. 43-54.

In reference 50, all possible alternative assignments, including exotic ones, were eliminated as the source of the novel series of peaks with energies of  $q \cdot 13.6 \text{ eV}$  where  $q = 1, 2, 3, 4, 6, 7, 8, 9, 11, 12$  or these lines inelastically scattered by helium atoms in the excitation of  $\text{He}(1s^2)$  to  $\text{He}(1s^1 2p^1)$  that were identified as hydrogen transitions to electronic energy levels below the "ground" state corresponding to fractional quantum numbers (**hydrino lines**).

Examiner Souw does not present any alternative explanation for the cited data.

Broadening was observed in glow discharge, RF discharge, and filament cells (rt-plasma) as well as microwave cells. Thus, the broadening is not dependent on the particular plasma

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<sup>94</sup> Reference Nos. 98, 101, 103-104

<sup>95</sup> Reference Nos. 103-104



source. Only those mixed plasma which contained a catalyst and hydrogen demonstrated broadening. Balmer  $\alpha$  line broadening is reported in references<sup>96</sup>. Standard broadening mechanisms were considered and eliminated including pressure broadening, resonance broadening, and microwave field broadening. Applicant confirmed that Doppler broadening due to thermal motion was the dominant source to the extent that other sources may be neglected when each source was considered. In general, the experimental profile is a convolution of two Doppler profiles, an instrumental profile, the natural (lifetime) profile, Stark profiles, van der Waals profiles, a resonance profile, and fine structure. The contribution from each source was determined to be below the limit of detection as shown in

49. R. L. Mills, P. Ray, E. Dayalan, B. Dhandapani, J. He, "Comparison of Excessive Balmer  $\alpha$  Line Broadening of Inductively and Capacitively Coupled RF, Microwave, and Glow Discharge Hydrogen Plasmas with Certain Catalysts", IEEE Transactions on Plasma Science, Vol. 31, No. (2003), pp. 338-355.
43. R. L. Mills, P. Ray, "Substantial Changes in the Characteristics of a Microwave Plasma Due to Combining Argon and Hydrogen", New Journal of Physics, www.njp.org, Vol. 4, (2002), pp. 22.1-22.17.
37. R. L. Mills, P. Ray, B. Dhandapani, R. M. Mayo, J. He, "Comparison of Excessive Balmer  $\alpha$  Line Broadening of Glow Discharge and Microwave Hydrogen Plasmas with Certain Catalysts", J. of Applied Physics, Vol. 92, No. 12, (2002), pp. 7008-7022.

In addition, only those plasma which contained a catalyst with hydrogen demonstrated other unique features such as the formation of a chemically generated hydrogen plasma (rt-plasma), novel spectral lines corresponding to lower-energy hydrogen states, and inverted hydrogen populations as discussed in:

84. R. L. Mills, P. Ray, J. Dong, M. Nansteel, R. M. Mayo, B. Dhandapani, X. Chen, "Comparison of Balmer  $\alpha$  Line Broadening and Power Balances of Helium-Hydrogen Plasma Sources", Plasma Sources Science and Technology, submitted.
74. R. L. Mills, P. C. Ray, R. M. Mayo, M. Nansteel, B. Dhandapani, J. Phillips, "Spectroscopic Study of Unique Line Broadening and Inversion in Low Pressure Microwave Generated Water Plasmas", Physics of Plasmas, submitted.

Additional data confirming the novel claimed reaction of atomic hydrogen to results in extraordinary H energy as measured by the broadening of the Balmer  $\alpha$  line are:

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<sup>96</sup> Reference Nos. 16, 20, 30, 33-37, 39, 42-43, 49, 51-52, 54-55, 57, 63-65, 68-69, 71-74, 81-85, 88-89, 91, 92, 93

16.) the observation by gas chromatography that hydrogen was consumed by the helium-hydrogen plasmas which showed the novel EUV series of lines with energies of  $q \cdot 13.6 \text{ eV}$ , the novel series of spectral lines due to the reaction  $2H(1/2) \rightarrow H_2(1/2)$  with vibronic coupling at energies of  $E_{D+vib} = 17.913 \pm \left(\frac{\nu^*}{3}\right) 0.515902 \text{ eV}$ , extraordinary H Balmer line broadening corresponding to 180 - 210 eV, and excess power of 21.9 W in  $3 \text{ cm}^3$ <sup>97</sup>,

27.) the observation of stationary inverted H Balmer and Lyman populations from a low pressure water-vapor microwave discharge plasma with an overpopulation sufficient for lasing at wavelengths over a wide range from micron to blue wherein molecular oxygen served as the catalyst as supported by  $O^{2+}$  emission and H Balmer line broadening of 55 eV compared to 1 eV for hydrogen alone<sup>98</sup>,

28.) the observation of H Balmer line broadening of 55 eV compared to 1 eV for hydrogen alone at distances up to 5 cm from the coupler<sup>99</sup>,

44.) the observation that glow discharge plasmas of the catalyst-hydrogen mixtures of strontium-hydrogen, helium-hydrogen, argon-hydrogen, strontium-helium-hydrogen, and strontium-argon-hydrogen showed significant Balmer  $\alpha$  line broadening corresponding to an average hydrogen atom temperature of 25 - 45 eV; whereas, plasmas of the noncatalyst-hydrogen mixtures of pure hydrogen, krypton-hydrogen, xenon-hydrogen, and magnesium-hydrogen showed no excessive broadening corresponding to an average hydrogen atom temperature of  $\approx 3 \text{ eV}$ <sup>100</sup>,

45.) the observation that microwave helium-hydrogen and argon-hydrogen plasmas having catalyst  $Ar^+$  or  $He^+$  showed extraordinary Balmer  $\alpha$  line broadening due to hydrogen catalysis corresponding to an average hydrogen atom temperature of 110 - 130 eV and 180 - 210 eV, respectively; whereas, plasmas of pure hydrogen, neon-hydrogen, krypton-hydrogen, and xenon-hydrogen showed no excessive broadening corresponding to an average hydrogen atom temperature of  $\approx 3 \text{ eV}$ <sup>101</sup>, and

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<sup>97</sup> Reference No. 76

<sup>98</sup> Reference Nos. 59, 65-66, 68, 74, 83, 85

<sup>99</sup> Reference No. 74

<sup>100</sup> Reference Nos. 16, 20, 30, 52, 72

<sup>101</sup> Reference Nos. 33-37, 43, 49, 60, 63-64, 69, 71, 73-74, 82, 84, 88, 92, 93

47.) the observation of significant Balmer  $\alpha$  line broadening of 17, 9, 11, 14, and 24 eV from rt-plasmas of incandescently heated hydrogen with  $K^+ / K^+$ ,  $Rb^+$ , cesium, strontium, and strontium with  $Ar^+$  catalysts, respectively, wherein the results could not be explained by Stark or thermal broadening or electric field acceleration of charged species since the measured field of the incandescent heater was extremely weak, 1 V/cm, corresponding to a broadening of much less than 1 eV<sup>102</sup>.

Applicant has correctly used Maxwell's equations to solve the atom and predict the new states of hydrogen. Applicant's use of first principles to solve problems on scales spanning 85 orders of magnitude is unprecedented and can not be matched with QM. Classical Quantum Mechanics (CQM) solves problems to greater accuracy than quantum mechanics (QM) and further solves problems which remain unsolvable by QM such as the basis of gravity, fundamental particles, and the acceleration of the expansion of the cosmos, all predicted accurately by Applicant's CQM.

As a specific example, problems that are intractable for QM can easily be solved by CQM such as the particle masses given in the Leptons section, the Proton and Neutron section, and the Quarks section of Ref. [1]:

## RELATIONS BETWEEN FUNDAMENTAL PARTICLES

The relations between the lepton masses and neutron to electron mass ratio which are independent of the definition of the imaginary time ruler  $ti$  including the contribution of the fields due to charge production are given in terms of the dimensionless fine structure constant  $\alpha$  only:

$$\frac{m_\mu}{m_e} = \left( \frac{\alpha^{-2}}{2\pi} \right)^{\frac{2}{3}} \frac{\left( 1 + 2\pi \frac{\alpha^2}{2} \right)}{\left( 1 + \frac{\alpha}{2} \right)} = 206.76828 \quad (206.76827)$$

$$\frac{m_\tau}{m_\mu} = \left( \frac{\alpha^{-1}}{2} \right)^{\frac{2}{3}} \frac{\left( 1 + \frac{\alpha}{2} \right)}{\left( 1 - 4\pi\alpha^2 \right)} = 16.817 \quad (16.817)$$

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<sup>102</sup> Reference Nos. 39, 42, 46, 51-52, 54-55, 57, 72, 81, 89, 91

$$\frac{m_r}{m_e} = \left( \frac{\alpha^{-3}}{4\pi} \right)^{\frac{2}{3}} \frac{\left( 1 + 2\pi \frac{\alpha^2}{2} \right)}{\left( 1 - 4\pi \alpha^2 \right)} = 3477.2 \quad (3477.3)$$

$$\frac{m_N}{m_e} = \frac{12\pi^2}{1-\alpha} \sqrt{\frac{3}{\alpha}} \frac{\left( 1 + 2\pi \frac{\alpha^2}{2} \right)}{\left( 1 - 2\pi \frac{\alpha^2}{2} \right)} = 1838.67 \quad (1838.68)$$

The success of Applicant's theory is summarized in a book review given by Landvogt.<sup>103</sup>

Some well-known facts were previously pointed out in detail by Applicant<sup>104</sup>—QM is postulated, purely mathematical, and can have no basis in reality. It only works because it tolerates renormalization and fictitious adjustable terms and parameters that are not physical and lack internal consistency. Considering the requirement of internal consistency and the adherence to physical laws, QM has never correctly solved a physical problem. It has many inescapable and intractable problems as documented in the following articles and references contained therein:

94. R. L. Mills, "The Nature of the Chemical Bond Revisited and an Alternative Maxwellian Approach", J. Phys. D, submitted.
80. R. L. Mills, The Fallacy of Feynman's Argument on the Stability of the Hydrogen Atom According to Quantum Mechanics, Foundations of Physics, submitted.
58. R. L. Mills, "Classical Quantum Mechanics", Physics Essays, submitted.
53. R. Mills, "A Maxwellian Approach to Quantum Mechanics Explains the Nature of Free Electrons in Superfluid Helium", Theoretical Chemistry Accounts, submitted.
22. R. Mills, "The Grand Unified Theory of Classical Quantum Mechanics", Global Foundation, Inc. Orbis Scientiae entitled *The Role of Attractive and Repulsive Gravitational Forces in Cosmic Acceleration of Particles The Origin of the Cosmic Gamma Ray Bursts*, (29th Conference on High Energy Physics and Cosmology Since 1964) Dr. Behram N. Kursunoglu, Chairman, December 14-17, 2000, Lago Mar Resort, Fort Lauderdale, FL, Kluwer Academic/Plenum Publishers, New York, pp. 243-258.
21. R. Mills, "The Grand Unified Theory of Classical Quantum Mechanics", Int. J. Hydrogen Energy, Vol. 27, No. 5, (2002), pp. 565-590.
17. R. Mills, "The Nature of Free Electrons in Superfluid Helium--a Test of Quantum Mechanics

<sup>103</sup> G. Landvogt, "The Grand Unified Theory of Classical Quantum Mechanics", International Journal of Hydrogen Energy, Vol. 28, No. 10, (2003), pp. 1155

<sup>104</sup> Reference Nos. 1, 5, 17, 21, 22, 53, 58, 80, 94

- and a Basis to Review its Foundations and Make a Comparison to Classical Theory", Int. J. Hydrogen Energy, Vol. 26, No. 10, (2001), pp. 1059-1096.
5. R. Mills, "The Hydrogen Atom Revisited", Int. J. of Hydrogen Energy, Vol. 25, Issue 12, December, (2000), pp. 1171-1183.
1. R. Mills, *The Grand Unified Theory of Classical Quantum Mechanics*, September 2001 Edition, BlackLight Power, Inc., Cranbury, New Jersey, Distributed by Amazon.com; July 2003 Edition posted at [www.blacklightpower.com](http://www.blacklightpower.com).

Ironically, Dirac originally attempted to solve the bound electron physically with stability with respect to radiation according to Maxwell's equations with the further constraints that it was relativistically invariant and gave rise to electron spin [1. P. Pearle, Foundations of Physics, "Absence of radiationless motions of relativistically rigid classical electron", Vol. 7, Nos. 11/12, (1977), pp. 931-945.]. He was unsuccessful and resorted to the current mathematical-probability-wave model that has many problems as discussed in Appendix II: Quantum Electrodynamics (QED) is Purely Mathematical and Has No Basis in Reality of Ref. [1]. From Weisskopf [V. F. Weisskopf, Reviews of Modern Physics, Vol. 21, No. 2, (1949), pp. 305-315], "Dirac's quantum electrodynamics gave a more consistent derivation of the results of the correspondence principle, but it also brought about a number of new and serious difficulties." Quantum electrodynamics; 1.) does not explain nonradiation of bound electrons; 2.) contains an internal inconsistency with special relativity regarding the classical electron radius—the electron mass corresponding to its electric energy is infinite; 3.) it admits solutions of negative rest mass and negative kinetic energy; 4.) the interaction of the electron with the predicted zero-point field fluctuations leads to infinite kinetic energy and infinite electron mass; 5.) Dirac used the unacceptable states of negative mass for the description of the vacuum; yet, infinities still arise.

Dirac's postulated relativistic wave equation also leads to the inescapable results that it gives rise to the Klein Paradox and a cosmological constant that is at least 120 orders of magnitude larger than the best observational limit as discussed in Chp. 1, Appendix II of Ref. [1] and previously<sup>105</sup>.

QM does not provide a basis for a "ground state" of the hydrogen atom beyond an arbitrary definition as discussed previously:

80. R. L. Mills, The Fallacy of Feynman's Argument on the Stability of the Hydrogen Atom According to Quantum Mechanics, Foundations of Physics, submitted.

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<sup>105</sup> Reference Nos. 5, 17, 21, 33, 53, 58, 80, 94

1. R. Mills, *The Grand Unified Theory of Classical Quantum Mechanics*, September 2001 Edition, BlackLight Power, Inc., Cranbury, New Jersey, Distributed by Amazon.com; January 2003 Edition posted at [www.blacklightpower.com](http://www.blacklightpower.com); Chps. 35-37.

Furthermore, as fully discussed in the main response, Applicant has more than met any burden he may have had to provide experimental evidence confirming the utility and operability of his disclosed invention. Over 50 articles are published in peer reviewed scientific journals and over 50 further articles have been submitted for peer-review:

**List of journals in which Applicant's articles have been published:**

Applied Physics Letters  
Chemistry of Materials  
Electrochimica Acta  
European Journal of Physics D  
Fusion Technology Journal of New Materials for Electrochemical Systems  
IEEE Transactions on Plasma Science  
International Journal of Hydrogen Energy  
Journal of Applied Physics  
Journal of Material Science  
Journal of Molecular Structure  
Journal of Optical Materials  
Journal of Plasma Physics  
Journal of Physics D: Applied Physics  
Journal of Quantitative Spectroscopy and Radiative Transfer  
Journal of New Materials for Electrochemical Systems  
New Journal of Physics  
Physics Essays  
Plasma Sources Science and Technology  
Solar Energy Materials & Solar Cells  
Thermochimica Acta  
Vibrational Spectroscopy

**List of journals to which Applicant's articles have been submitted and are being reviewed:**

Acta Physica Polonica A  
AIAA Journal

Brazilian Journal of Physics

Canadian Journal of Physics

Central European Journal of Physics

Chemical Engineering Science

Contributions to Plasma Physics

Current Applied Physics

European Journal of Physics D

Europhysics Letters

Fizika A

Foundations of Science

IEEE Transactions on Plasma Science

Journal of Mathematical Physics

Journal of Applied Physics

Journal of Materials Research

Journal of Physical Chemistry A

Journal of Physical Chemistry B

Journal of Physics D, Applied Physics

Journal of Plasma Physics

Journal of Applied Spectroscopy

Journal of Vacuum Science & Technology A

Journal of Quantitative Spectroscopy and Radiative Transfer

Materials Characterization

Materials Chemistry and Physics

New Journal of Chemistry

New Journal of Physics

Physics Essays

Physical Review B

Physica Scripta

Spectrochimica Acta Part B: Atomic Spectroscopy

Thin Solid Films

Applicant's use of the terminology Rydberg states is justified and appears in peer reviewed journal articles. From Ref. [67], R. L. Mills, P. Ray, "Extreme Ultraviolet Spectroscopy of Helium-Hydrogen Plasma", J. Phys. D, Applied Physics, Vol. 36, (2003), pp. 1535-1542:

The elimination of known explanations indicate a new result. Since the novel peaks were only observed with helium and hydrogen present, new hydrogen, helium, or helium-hydrogen species are possibilities. It is well known that empirically the excited energy states of atomic hydrogen are given by **Rydberg** equation (Eq. (2a) for  $n > 1$  in Eq. (2b)).

$$E_n = -\frac{e^2}{n^2 8 \pi \epsilon_0 a_H} = -\frac{13.598 \text{ eV}}{n^2} \quad (2a)$$

$$n = 1, 2, 3, \dots \quad (2b)$$

The  $n = 1$  state is the "ground" state for "pure" photon transitions (i.e. the  $n = 1$  state can absorb a photon and go to an excited electronic state, but it cannot release a photon and go to a lower-energy electronic state). However, an electron transition from the ground state to a lower-energy state may be possible by a resonant nonradiative energy transfer such as multipole coupling or a resonant collision mechanism. Processes such as hydrogen molecular bond formation that occur without photons and that require collisions are common<sup>106</sup>. Also, some commercial phosphors are based on resonant nonradiative energy transfer involving multipole coupling<sup>107</sup>.

We propose that atomic hydrogen may undergo a catalytic reaction with certain atoms and ions such as  $He^+$  which singly or multiply ionize at integer multiples of the potential energy of atomic hydrogen,  $m \cdot 27.2 \text{ eV}$  wherein  $m$  is an integer. The theory was given previously<sup>108</sup>. The reaction involves a nonradiative energy transfer to form a hydrogen atom that is lower in energy than unreacted atomic hydrogen that corresponds to a fractional principal quantum number. That is

$$n = \frac{1}{2}, \frac{1}{3}, \frac{1}{4}, \dots, \frac{1}{p}; \quad p \text{ is an integer; } p \leq 137 \quad (2c)$$

replaces the well known parameter  $n = \text{integer}$  in the **Rydberg** equation for hydrogen excited states. **Thus, the Rydberg states are extended to lower levels as depicted in Figure 9.** The  $n = 1$  state of hydrogen and the  $n = \frac{1}{\text{integer}}$  states of hydrogen are nonradiative, but a

<sup>106</sup> Reference No. 47

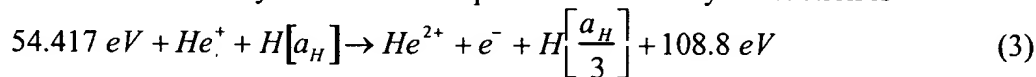
<sup>107</sup> Reference No. 48

<sup>108</sup> Reference No. 49

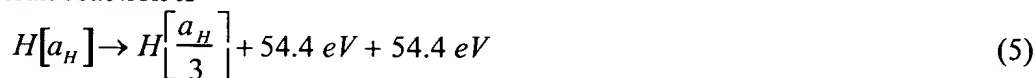


transition between two nonradiative states is possible via a nonradiative energy transfer, say  $n = 1$  to  $n = 1/2$ . Thus, a catalyst provides a net positive enthalpy of reaction of  $m \cdot 27.2 \text{ eV}$  (i.e. it resonantly accepts the nonradiative energy transfer from hydrogen atoms and releases the energy to the surroundings to affect electronic transitions to fractional quantum energy levels). As a consequence of the nonradiative energy transfer, the hydrogen atom becomes unstable and emits further energy until it achieves a lower-energy nonradiative state having a principal energy level given by Eqs. (2a) and (2c).

The novel peaks fit two empirical relationships. In order of energy, the set comprising the peaks at  $91.2 \text{ nm}$ ,  $45.6 \text{ nm}$ ,  $30.4 \text{ nm}$ ,  $13.03 \text{ nm}$ ,  $10.13 \text{ nm}$ , and  $8.29 \text{ nm}$  correspond to energies of  $q \cdot 13.6 \text{ eV}$  where  $q = 1, 2, 3, 7, 9, 11$ . In order of energy, the set comprising the peaks at  $37.4 \text{ nm}$ ,  $20.5 \text{ nm}$ , and  $14.15 \text{ nm}$  correspond to energies of  $q \cdot 13.6 - 21.21 \text{ eV}$  where  $q = 4, 6, 8$ . These lines can be explained as electronic transitions to **fractional Rydberg states** of atomic hydrogen given by Eqs. (2a) and (2c) wherein the catalytic system involves helium ions because the second ionization energy of helium is  $54.417 \text{ eV}$ , which is equivalent to  $2 \cdot 27.2 \text{ eV}$ . In this case,  $54.417 \text{ eV}$  is transferred nonradiatively from atomic hydrogen to  $\text{He}^+$  which is resonantly ionized. The electron decays to the  $n = 1/3$  state with the further release of  $54.417 \text{ eV}$  which may be emitted as a photon. The catalysis reaction is

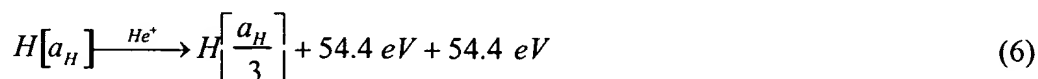


And, the overall reaction is



Since the products of the catalysis reaction have binding energies of  $m \cdot 27.2 \text{ eV}$ , they may further serve as catalysts. Thus, further catalytic transitions may occur:  $n = \frac{1}{3} \rightarrow \frac{1}{4}$ ,  $\frac{1}{4} \rightarrow \frac{1}{5}$ , and so on.

**Electronic transitions to Rydberg states given by Eqs. (2a) and (2c)** catalyzed by the resonant nonradiative transfer of  $m \cdot 27.2 \text{ eV}$  would give rise to a series of emission lines of energies  $q \cdot 13.6 \text{ eV}$  where  $q$  is an integer. It is further proposed that the photons that arise from hydrogen transitions may undergo inelastic helium scattering. That is, the catalytic reaction

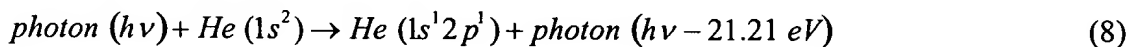


yields  $54.4 \text{ eV}$  by Eq. (4) and a photon of  $54.4 \text{ eV}$  ( $22.8 \text{ nm}$ ). Once emitted, the photon may be absorbed or scattered. When this photon strikes  $\text{He}(1s^2)$ ,  $21.2 \text{ eV}$  may be absorbed in the excitation to  $\text{He}(1s^1 2p^1)$ . This leaves a  $33.19 \text{ eV}$  ( $37.4 \text{ nm}$ ) photon peak and a  $21.21 \text{ eV}$

(58.4 nm) photon from  $He(1s^1 2p^1)$ . Thus, for helium the inelastic scattered peak of 54.4 eV photons from Eq. (3) is given by

$$E = 54.4 \text{ eV} - 21.21 \text{ eV} = 33.19 \text{ eV} \text{ (37.4 nm)} \quad (7)$$

A novel peak shown in Figures 2-4 was observed at 37.4 nm. Furthermore, the intensity of the 58.4 nm peak corresponding to the spectra shown in Figure 4 was about 60,000 photons/sec. Thus, the transition  $He(1s^2) \rightarrow He(1s^1 2p^1)$  dominated the inelastic scattering of EUV peaks. The general reaction is



The two empirical series may be combined—one directly from Eqs. (2a, 2c) and the other indirectly with Eq. (8). The energies for the novel lines in order of energy are 13.6 eV, 27.2 eV, 40.8 eV, 54.4 eV, 81.6 eV, 95.2 eV, 108.8 eV, 122.4 eV and 149.6 eV. The corresponding peaks are 91.2 nm, 45.6 nm, 30.4 nm, 37.4 nm, 20.5 nm, 13.03 nm, 14.15 nm, 10.13 nm, and 8.29 nm, respectively. Thus, the identified novel lines correspond to energies of  $q \cdot 13.6 \text{ eV}$ ,  $q = 1, 2, 3, 7, 9, 11$ , or  $q \cdot 13.6 \text{ eV}$ ,  $q = 4, 6, 8$  less 21.2 eV corresponding to inelastic scattering of these photons by helium atoms due to excitation of  $He(1s^2)$  to  $He(1s^1 2p^1)$ . The values of  $q$  observed are consistent with those expected based on Eq. (5) and the subsequent autocatalyzed reactions as discussed previously<sup>109</sup>. The broad satellite peak at 44.2 nm show in Figure 2-4 is consistent with the reaction mechanism of a nonradiative transfer to a catalyst followed by emission. **There is remarkable agreement between the data and the proposed transitions to fractional Rydberg states** and these lines inelastically scattered by helium according to Eq. (8). All other peaks could be assigned to He I, He II, second order lines, or atomic or molecular hydrogen emission. No known lines of helium or hydrogen explain the  $q \cdot 13.6 \text{ eV}$  related set of peaks.

These data confirm the products of the claimed reaction such as 1.) power, 2.) plasma from the energetic reaction, 3.) fast H arising from the energy transfer from H undergoing a transition to a lower-energy state to the subsequent fast H acting as a colliding body to conserve energy and momentum, and 4.) novel compounds including new hydride compounds.

Based on the data presented herewith, there is ample basis to propose commercial applications. The data has its characteristics such as plasma formation<sup>110</sup>, population inversion of hydrogen lines<sup>111</sup>, power generation<sup>112</sup>, excessive light emission<sup>113</sup>, and novel chemical

<sup>109</sup> Reference No. 50

<sup>110</sup> Reference Nos. 11-13, 15-16, 20, 24, 27, 32, 39, 42, 46-47, 51-52, 54-55, 57, 72, 81, 89, 91-93

<sup>111</sup> Reference Nos. 39, 46, 51, 54, 55, 57, 59, 65-66, 68, 74, 83, 85, 89, 91

<sup>112</sup> Reference Nos. 30-31, 33, 35-36, 39, 43, 50, 63, 71-73, 76-77, 81, 84, 89, 92, 93

<sup>113</sup> Reference Nos. 11, 16, 20, 23, 31, 37, 43, 52, 72

compounds <sup>114</sup> independent of the underlying hydrino hypothesis as does direct plasma to electric power conversion<sup>115</sup>. Furthermore, the scientific hypothesis based on Maxwell's equations is valid and using the flawed QM as basis for discounting Applicant's disclosed invention is erroneous. The inescapable problems of QM including its inability to provide a physical basis for the "ground" state of atomic hydrogen are discussed in:

94. R. L. Mills, "The Nature of the Chemical Bond Revisited and an Alternative Maxwellian Approach", J. Phys. D, submitted.
80. R. L. Mills, The Fallacy of Feynman's Argument on the Stability of the Hydrogen Atom According to Quantum Mechanics, Foundations of Physics, submitted.
58. R. L. Mills, "Classical Quantum Mechanics", Physics Essays, submitted.
53. R. Mills, "A Maxwellian Approach to Quantum Mechanics Explains the Nature of Free Electrons in Superfluid Helium", Theoretical Chemistry Accounts, submitted.
22. R. Mills, "The Grand Unified Theory of Classical Quantum Mechanics", Global Foundation, Inc. Orbis Scientiae entitled *The Role of Attractive and Repulsive Gravitational Forces in Cosmic Acceleration of Particles The Origin of the Cosmic Gamma Ray Bursts*, (29th Conference on High Energy Physics and Cosmology Since 1964) Dr. Behram N. Kursunoglu, Chairman, December 14-17, 2000, Lago Mar Resort, Fort Lauderdale, FL, Kluwer Academic/Plenum Publishers, New York, pp. 243-258.
21. R. Mills, "The Grand Unified Theory of Classical Quantum Mechanics", Int. J. Hydrogen Energy, Vol. 27, No. 5, (2002), pp. 565-590.
17. R. Mills, "The Nature of Free Electrons in Superfluid Helium--a Test of Quantum Mechanics and a Basis to Review its Foundations and Make a Comparison to Classical Theory", Int. J. Hydrogen Energy, Vol. 26, No. 10, (2001), pp. 1059-1096.
5. R. Mills, "The Hydrogen Atom Revisited", Int. J. of Hydrogen Energy, Vol. 25, Issue 12, December, (2000), pp. 1171-1183.
1. R. Mills, *The Grand Unified Theory of Classical Quantum Mechanics*, September 2001 Edition, BlackLight Power, Inc., Cranbury, New Jersey, Distributed by Amazon.com; July 2003 Edition posted at [www.blacklightpower.com](http://www.blacklightpower.com).

e.) Examiner Souw cites Applicant's paper:

28. R. Mills, P. Ray, "Spectral Emission of Fractional Quantum Energy Levels of Atomic

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<sup>114</sup> Reference Nos. 6-10, 19, 25, 38, 41, 44-45, 60-62, 64, 69, 75, 81-82, 87-88, 90, 92, 93, 94

<sup>115</sup> Reference Nos. 18, 26, 40, 48, 56, 68

Hydrogen from a Helium-Hydrogen Plasma and the Implications for Dark Matter", Int. J. Hydrogen Energy, (2002), Vol. 27, No. 3, pp. 301-322.

as failing to identify the 304 Å line as the He II line. The Examiner shows carelessness and has erred since Applicant has assigned the 304 Å to He II. Table 1 of gives:

304	304	$He^+(n=2) \rightarrow He^+(n=1) + 40.8 \text{ eV}^b$	7, 8, 9, 10, 12
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In the legend appears:

<sup>b</sup> In Figures 7, 8, 9, 10, and 12, the peak corresponding to  $He^+(n=3) \rightarrow He^+(n=1) + 48.35 \text{ eV}$  (256 Å) was absent which makes this assignment difficult.

Furthermore, in Sec. IIIA appears:

It is also proposed that the 304 Å peak shown in Figures 7, 8, 9, 10 and 12 was not entirely due to the He II transition. Conspicuously absent was the 256 Å (48.3 eV) line of He II shown in Figures 6 and 8 which implies only a minor He II transition contribution to the 304 Å peak.

The solar spectrum is not the same as the spectrum of a pure helium-hydrogen (98/2%) plasma. The Sun is known to contain the elements even beyond iron (See Table 4.2 of Stix, M., The Sun, Springer-Verlag, Berlin, (1991)). Based on the Examiner's errors and using the same standard as the Examiner applies to Applicant, his scientific credibility is compromised on **all** of his arguments.

Applicant respectfully submits that Examiner Souw is confused regarding Balmer line broadening. As given in **Appendix #2**, Applicant does not claim resonance broadening, rather the source of Balmer line broadening is Doppler broadening. The resonance ionization involves the catalyst as given for the  $He^+$  in **Appendix b**. The catalyst reaction involves a nonradiative, resonant energy transfer of  $m \cdot 27.2 \text{ eV}$  to a catalyst followed the remaining energy between the initial and final states being released as a photon or transferred to a body such as H to form fast H. The resulting broadening is Doppler.

Hydrogen does not emit below 80 nm, the emission region of the novel series of peaks with energies of  $q \cdot 13.6 \text{ eV}$  where  $q = 1, 2, 3, 4, 6, 7, 8, 9, 11, 12$  or these lines inelastically scattered by helium atoms in the excitation of  $He(1s^2)$  to  $He(1s^1 2p^1)$ . These lines having wavelengths shorter than those of the Lyman lines were identified as hydrogen transitions to electronic energy levels below the "ground" state corresponding to fractional quantum numbers (**hydrino lines**). See Appendix #1. In the case of hydrogen Lyman emission due to plasma formation<sup>116</sup>, there is no EUV emission in the controls. The formation of a plasma at low temperature with low or no electric field requirement is a first and quite unexpected. The plasma formation only occurs for those systems where catalyst is present. The predicted catalyst emission is observed. The predicted novel hydride ion emission is observed, and novel chemical compounds are formed. The plasma (rt-plasma) was independently replicated and alternative explanations were eliminated by top plasma physicists<sup>117</sup>. The Examiner has offered no plausible alternative explanation as to why a very energetic plasma should form with the heating of trace amounts of an inorganic compound and low pressure hydrogen gas.

Data clearly showing that the predicted catalytic hydrogen reaction occurs in these plasma includes:

1.) the observation of intense extreme ultraviolet (EUV) emission at low temperatures (e.g.  $\approx 10^3 \text{ K}$ ) from atomic hydrogen and only those atomized elements or gaseous ions which provide a net enthalpy of reaction of approximately  $m \cdot 27.2 \text{ eV}$  via the ionization of  $t$  electrons to a continuum energy level where  $t$  and  $m$  are each an integer (e.g.  $K$ ,  $Cs$ , and  $Sr$  atoms and  $Rb^+$  ion ionize at integer multiples of the potential energy of atomic hydrogen and caused emission; whereas, the chemically similar atoms,  $Na$ ,  $Mg$ , and  $Ba$ , do not ionize at integer multiples of the potential energy of atomic hydrogen and caused no emission)<sup>118</sup>,

2.) the observation of novel EUV emission lines from microwave and glow discharges of helium with 2% hydrogen with energies of  $q \cdot 13.6 \text{ eV}$  where  $q = 1, 2, 3, 4, 6, 7, 8, 9, 11, 12$  or these lines inelastically scattered by helium atoms in the excitation of  $He(1s^2)$  to  $He(1s^1 2p^1)$  that were identified as hydrogen transitions to electronic energy levels below the "ground" state corresponding to fractional quantum numbers<sup>119</sup>,

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<sup>116</sup> Reference Nos. 11-13, 15-16, 20, 24, 27, 32, 39, 42, 46-47, 51-52, 54-55, 57, 72, 81, 89, 91-93

<sup>117</sup> Reference No. 47

<sup>118</sup> Reference Nos. 11-13, 15-16, 20, 24, 27, 32, 39, 42, 46-47, 51-52, 54-55, 57, 72, 81, 89, 91-93

<sup>119</sup> Reference Nos. 28, 33-36, 50, 63, 67, 71, 73, 75-76, 78, 86-87, 90, 92, 93

18.) the observation of continuum state emission of  $Cs^{2+}$  and  $Ar^{2+}$  at 53.3 nm and 45.6 nm, respectively, with the absence of the other corresponding Rydberg series of lines from these species which confirmed the resonant nonradiative energy transfer of 27.2 eV from atomic hydrogen to the either Cs or  $Ar^+$  catalyst<sup>120</sup>,

19.) the spectroscopic observation of the predicted hydride ion  $H^-(1/2)$  of hydrogen catalysis by either Cs or  $Ar^+$  catalyst at 407 nm corresponding to its predicted binding energy of 3.05 eV<sup>121</sup>,

20.) the observation of characteristic emission from  $K^{3+}$  which confirmed the resonant nonradiative energy transfer of 3·27.2 eV from atomic hydrogen to atomic K<sup>122</sup>,

21.) the spectroscopic observation of the predicted  $H^-(1/4)$  ion of hydrogen catalysis by K catalyst at 110 nm corresponding to its predicted binding energy of 11.2 eV<sup>123</sup>,

22.) the observation of characteristic emission from  $Rb^{2+}$  which confirmed the resonant nonradiative energy transfer of 27.2 eV from atomic hydrogen to  $Rb^+$ <sup>124</sup>,

23.) the spectroscopic observation of the predicted  $H^-(1/2)$  ion of hydrogen catalysis by  $Rb^+$  catalyst at 407 nm corresponding to its predicted binding energy of 3.05 eV<sup>125</sup>,

24.) the observation of  $H^-(1/2)$ , the hydride ion catalyst product of  $K^+ / K^+$  or  $Rb^+$ , at its predicted binding energy of 3.0468 eV by high resolution visible spectroscopy as a continuum threshold at 4068.2 Å and a series of structures peaks separated from the binding energy by an integer multiple of the fine structure of  $H(1/2)$  starting at 4071 Å<sup>126</sup>,

25.) the observation that the high resolution visible  $K^+ / K^+$  or  $Rb^+ - H_2$  plasma emission spectra in the region of 4995 to 4060 Å matched the predicted bound-free hyperfine structure lines  $E_{HF}$  of  $H^-(1/2)$  calculated from the electron g factor as

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<sup>120</sup> Reference Nos. 24, 39, 51, 54-55, 57, 91

<sup>121</sup> Reference No. 24

<sup>122</sup> Reference Nos. 27, 39, 42, 46, 51, 54-55, 57, 81, 89, 91

<sup>123</sup> Reference Nos. 81, 42, 27

<sup>124</sup> Reference Nos. 32, 39, 42, 46, 51, 54-55, 57, 81, 89, 91

<sup>125</sup> Reference No. 32

<sup>126</sup> Reference Nos. 39, 42, 46, 57, 81, 89, 91

$E_{HF} = j^2 3.00213 \times 10^{-5} + 3.0563 \text{ eV}$  ( $j$  is an integer) for  $j = 1$  to  $j = 39$  (3.0563 eV to 3.1012 eV—the hydride binding energy peak plus one and five times the spin-pairing energy, respectively) to within a 1 part per  $10^{4127}$ ,

26.)  $Rb^+$  or  $2K^+$  catalysts formed a plasma having strong VUV emission with a stationary inverted Lyman population with an overpopulation sufficient for lasing, and emission from  $H^-(1/2)$  was observed at 4071 Å corresponding to its predicted binding energy of 3.0468 eV with the fine structure and its predicted bound-free hyperfine structure lines  $E_{HF} = j^2 3.00213 \times 10^{-5} + 3.0563 \text{ eV}$  ( $j$  is an integer) that matched for  $j = 1$  to  $j = 37$  to within a 1 part per  $10^{4128}$ ,

### Response to comments on former Attachment #38

Referring to Applicant's publication Ref. [45], R. L. Mills, J. He, P. Ray, B. Dhandapani, X. Chen, "Synthesis and Characterization of a Highly Stable Amorphous Silicon Hydride as the Product of a Catalytic Helium-Hydrogen Plasma Reaction", Int. J. Hydrogen Energy, Vol. 28, No. 12, (2003), pp. 1401-1424.

Hydrogen has only one proton; thus it has the smallest XPS cross section. The peak intensities are predicted to be low. However, H is the only element that does not have any other primary peaks in the high binding energy region. These peaks are much more intense than the peaks in the low-binding energy region. Thus, H can be identified. The time of flight secondary ion mass spectroscopy (ToF-SIMS) identified the coatings as hydride by the large  $SiH^+$  peak in the positive spectrum and the dominant  $H^-$  in the negative spectrum. X-ray photoelectron spectroscopy (XPS) identified the H content of the  $SiH$  coatings as hydride ions,  $H^-(1/4)$ ,  $H^-(1/9)$ , and  $H^-(1/11)$  corresponding to peaks at 11, 43, and 55 eV, respectively.

Referring to the following section of Ref. [45]:

### b. XPS Characterization

The XPS survey spectra of the noncoated cleaned commercial silicon wafer (control) and a nickel foil coated with an  $\alpha - SiH$  film and exposed to air for 20 min were obtained over the region  $E_b = 0 \text{ eV}$  to 1200 eV and are shown in Figures 18 and 19, respectively. The survey spectra permitted the determination of all of the elements present and detected shifts in the binding energies of the Si 2p peak, which also identifies the presence or absence of

<sup>127</sup> Reference Nos. 39, 42, 46, 57, 81, 89, 91

<sup>128</sup> Reference Nos. 39, 42, 46, 51, 54, 55, 57, 81, 89, 91

$\text{SiO}_2$ . The major species identified in the XPS spectrum of the control sample were silicon, oxygen, and carbon. The  $\alpha - \text{SiH}$  sample contained essentially silicon with negligible oxygen and carbon.

The XPS spectra (96-108 eV) in the region of the  $\text{Si } 2p$  peak of the noncoated cleaned commercial silicon wafer and a nickel foil coated with an  $\alpha - \text{SiH}$  film and exposed to air for 20 min. are shown in Figures 20 and 21, respectively. The XPS spectrum of the control silicon wafer shows a large  $\text{SiO}_2$  content at 104 eV as given by Wagner et al. [C. D. Wagner, W. M. Riggs, L. E. Davis, J. F. Moulder, G. E. Mulilenberg (Editor), *Handbook of X-ray Photoelectron Spectroscopy*, Perkin-Elmer Corp., Eden Prairie, Minnesota, (1997)]. In contrast, the  $\alpha - \text{SiH}$  sample had essentially no  $\text{SiO}_2$ . In addition, spin-orbital coupling gives rise to a split  $\text{Si } 2p$  peak in pure silicon, but this peak changed to a single broad peak upon reaction to form the  $\alpha - \text{SiH}$  film indicative of amorphous silicon.

The XPS spectrum (96-108 eV) in the region of the  $\text{Si } 2p$  peak of a nickel foil coated with an  $\alpha - \text{SiH}$  film and exposed to air for 48 hours before the XPS analysis is shown in Figure 22. Essentially no  $\text{SiO}_2$  was observed at 104 eV demonstrating that the sample was extraordinarily stable to air exposure. Perhaps trace  $\text{SiOH}$  is present in the region of 102 eV potentially due to less than 100% coverage of the surface with the  $\alpha - \text{SiH}$  film; rather, some silicon deposition may have occurred. In contrast, the XPS spectrum (96-108 eV) in the region of the  $\text{Si } 2p$  peak of the  $\text{HF}$  cleaned silicon wafer exposed to air for 10 min. before XPS analysis was essentially fully covered by partial oxides  $\text{SiO}_x$  such as  $\text{SiOH}$ . The mixed silicon oxide peak in the region of 101.5-104 eV shown in Figure 23 was essentially the same percentage of the  $\text{Si } 2p$  as that of the  $\text{SiO}_2$  peak of the uncleaned wafer shown at 104 eV in Figure 20. In addition, the  $\text{O } 1s$  peak of the  $\alpha - \text{SiH}$  film exposed to air for 48 hours shown in Figure 24 was negligible; whereas, that of the  $\text{HF}$  cleaned wafer exposed to air for 10 min. was intense as shown in Figure 25.

The 0-70 eV and the 0-85 eV binding energy region of high resolution XPS spectra of the commercial silicon wafer and a  $\text{HF}$  cleaned silicon wafer exposed to air for 10 min. before XPS analysis are shown in Figures 26 and 27, respectively. Only a large  $\text{O } 2s$  peak in the low binding energy region was observed in each case. The 0-70 eV binding energy region of a nickel foil coated with an  $\alpha - \text{SiH}$  film and exposed to air for 20 min. before XPS analysis is shown in Figure 28. By comparison of the  $\alpha - \text{SiH}$  sample to the controls, novel XPS peaks were identified at 11, 43, and 55 eV. These peaks do not correspond to any of the primary elements, silicon, carbon, or oxygen, shown in the survey scan in Figure 19, wherein the peaks of these elements are given by Wagner et al. [C. D. Wagner, W. M. Riggs, L. E. Davis, J. F. Moulder, G. E. Mulilenberg (Editor), *Handbook of X-ray Photoelectron Spectroscopy*, Perkin-Elmer Corp., Eden Prairie, Minnesota, (1997)]. Hydrogen is the only



element which does not have primary element peaks; thus, it is the only candidate to produce the novel peaks and correspond to the  $H$  content of the  $SiH$  coatings. These peaks closely matched and were assigned to hydride ions,  $H^-(1/4)$ ,  $H^-(1/9)$ , and  $H^-(1/11)$ , respectively, given by Eqs (4-5). The novel hydride ions are proposed to form by the catalytic reaction of  $He^+$  with atomic hydrogen and subsequent autocatalytic reactions of  $H(1/p)$  to form highly stable silicon hydride products  $\alpha - SiH$  comprising  $SiH(1/p)$  ( $p$  is an integer greater than one in Eqs. (4-5)).

The XPS spectra of the  $Si\ 2p$  region were analyzed, and it was found that the  $Si\ 2p$  peak was shifted 0.3-0.7 eV for the  $\alpha - SiH$  films relative to that of the  $HF$  cleaned silicon wafer as shown in Figures 21 and 22 compared to Figure 20. The shift was due to the influence of the hydride ions since no other counter ion peaks were observed as shown by the survey scan, Figure 19. The stability and the intensity of the hydride ion peaks in the low binding energy region were correlated with the shift of the  $Si\ 2p$  peaks as shown by the shift of 0.3 eV in Figure 21 compared to a 0.7 eV shift in Figure 22. This provides further evidence of a novel  $\alpha - SiH$  film with increased stability due to the novel hydride ions.

These results indicate that the plasma reaction formed a highly stable novel hydrogenated coating; whereas, the control comprised an oxide coating or an ordinary hydrogen terminated silicon surface which rapidly formed an oxide passivation layer. The hydrogen content of the  $\alpha - SiH$  coating appears to be novel hydride ions with high binding energies which account for the exceptional air stability.

The additional reported data supports the catalytic reaction and products of Applicant's disclosed invention. Specifically, microwave helium-hydrogen plasmas showed extraordinary broadening, and the corresponding extremely high hydrogen-atom temperature of 180 - 210 eV was observed with the presence of helium ion catalyst only with hydrogen present. Using water bath calorimetry, excess power was observed from the helium-hydrogen plasma compared to control krypton plasma. For a 8.1 W input, the thermal output power of the helium-hydrogen plasma was measured to be 30.0 W corresponding to 21.9 W of excess power in  $3\ cm^3$ . The excess power density and energy balance were high,  $7.3\ W/cm^3$  and  $-2.9 \times 10^4\ kJ/mole\ H_2$ , respectively.

The energetic plasma reaction was used to synthesize a potentially commercially important product. Nickel substrates were coated by the reaction product of a low pressure microwave discharge plasma of  $SiH_4$  (2.5%)/  $He$  (96.6%)/  $H_2$  (0.9%). The ToF-SIMS identified the coatings as hydride by the large  $SiH^+$  peak in the positive spectrum and the dominant  $H^-$  in the negative spectrum. XPS identified the  $H$  content of the  $SiH$  coatings as hydride ions,  $H^-(1/4)$ ,  $H^-(1/9)$ , and  $H^-(1/11)$  corresponding to predicted peaks at 11, 43, and 55 eV,

respectively (See the Hydrino Hydride Ion section of Ref. [1]). The novel hydride ions are proposed to form by the catalytic reaction of  $He^+$  with atomic hydrogen and subsequent autocatalytic reactions of  $H(1/p)$  to form highly stable silicon hydride products  $SiH(1/p)$  ( $p$  is an integer greater than one in Eqs. (4-5)) of Ref [R. Mills, "Spectroscopic Identification of a Novel Catalytic Reaction of Atomic Hydrogen and the Hydride Ion Product", Int. J. Hydrogen Energy, Vol. 26, No. 10, (2001), pp. 1041-1058]. The  $SiH$  coating was amorphous as indicated by the shape of the  $Si\ 2p$  peak and was remarkably stable to air exposure. After a 48 hour exposure to air, essentially no oxygen was observed as evidence by the negligible  $O\ 1s$  peak at 531 eV and absence of any  $SiO_x\ Si\ 2p$  peak in the region of 102-104 eV. The highly stable amorphous silicon hydride coating may advance the production of integrated circuits and microdevices by resisting the oxygen passivation of the surface and possibly altering the dielectric constant and band gap to increase device performance.

Water is not present in the plasma. The amorphous silicon layer is formed from a plasma containing silane which is violently explosive on exposure to water vapor. Oxygen and carbon are only present in trace. The survey spectrum and the ToF-SIMS analysis does not show any impurities that explain the peaks in the low binding energy region proposed by the Examiner. The Examiner proposes no specific alternative assignment. This is not good science. The Examiner's credibility is further eroded given his reliance on a argument in which he has erred regarding Applicant's assignment of the He II line in Table 1 of reference [28], and his presentation of the Solar spectrum as equivalent to that of a pure helium-hydrogen (98/2%) plasma further undermines his scientific credibility.

#### **Response to Arguments "Specifically regarding Attachment #1"**

The NASA-funded team conducted independent studies of Balmer line broadening, power balance, and H line inversion on Applicant's plasma. Applicant's results were replicated confirming the utility of his invention.

Specifically, referring to Ref. No. 44 cited in the section of Applicant's main response entitled "**Independent Test Results**":

44. **A. J. Marchese, P. M. Jansson, J. L. Schmalzel, "The BlackLight Rocket Engine", Phase I Final Report, NASA Institute for Advanced Concepts Phase I, May 1-November 30, 2002, [http://www.niac.usra.edu/files/studies/final\\_report/pdf/752Marchese.pdf](http://www.niac.usra.edu/files/studies/final_report/pdf/752Marchese.pdf).**

Rowan University Professors A. J. Marchese, P. M. Jansson, J. L. Schmalzel performed verification studies as visiting researchers at BlackLight Power, Cranbury, NJ. The prior reported results of BlackLight Power, Inc. of extraordinarily broadened atomic hydrogen lines, population inversion, lower-energy hydrogen lines, and excess power measured by water bath

calorimetry were replicated. The application of the energetic hydrogen to propulsion was studied.

Specifically, the data supporting hydrinos was replicated, as can be seen in:

- i.) BlackLight Process Theory (pp. 10-12) which gives the theoretical energy levels for hydrinos and the catalytic reaction to form hydrinos;
- ii.) Unique Hydrogen Line Broadening in Low Pressure Microwave Water Plasmas (pp. 25-27, particularly Fig. 21) which shows that in the same microwave cavity driven at the same power, the temperature of the hydrogen atoms in the microwave plasma where the hydrino reaction was active was 50 times that of the control based on the spectroscopic line widths;
- iii.) Inversion of the Line Intensities in Hydrogen Balmer Series (pp. 27-28, particularly Fig. 22) which shows for the first time in 40 years of intensive worldwide research that atomic hydrogen population inversion was achieved in a steady state plasma and supports the high power released from the reaction of hydrogen to form hydrinos;
- iv.) Novel Vacuum Ultraviolet (VUV) Vibration Spectra of Hydrogen Mixture Plasmas (pp. 28-29, particularly Fig. 23) which shows a novel vibrational series of lines in a helium-hydrogen plasmas at energies higher than any known vibrational series and it identically matches the theoretical prediction of 2 squared times the corresponding vibration of the ordinary hydrogen species; and
- v.) Water Bath Calorimetry Experiments Showing Increased Heat Generation (pp. 29-30, particularly Fig. 25) that shows that with exactly the same system and same input power, the heating of the water reservoir absolutely measured to 1% accuracy was equivalent to 55 to 62 W with the catalyst-hydrogen mixture compared to 40 W in the control without the possibility of the reaction to form hydrinos.

#### **Response to Arguments "Specifically regarding Attachments #46 and #53"**

The response to the Balmer line broadening issue raise by the Examiner is covered in **Appendix #2** and at **Appendix d**. The deviations based on Maxwell's equations are fully compliant with electromagnetic theory and special relativity; whereas, QM has serious problems as discussed in:

- 94. R. L. Mills, "The Nature of the Chemical Bond Revisited and an Alternative Maxwellian Approach", J. Phys. D, submitted.
- 80. R. L. Mills, The Fallacy of Feynman's Argument on the Stability of the Hydrogen Atom According to Quantum Mechanics, Foundations of Physics, submitted.
- 58. R. L. Mills, "Classical Quantum Mechanics", Physics Essays, submitted.
- 53. R. Mills, "A Maxwellian Approach to Quantum Mechanics Explains the Nature of Free

- Electrons in Superfluid Helium", Theoretical Chemistry Accounts, submitted.
22. R. Mills, "The Grand Unified Theory of Classical Quantum Mechanics", Global Foundation, Inc. Orbis Scientiae entitled *The Role of Attractive and Repulsive Gravitational Forces in Cosmic Acceleration of Particles The Origin of the Cosmic Gamma Ray Bursts*, (29th Conference on High Energy Physics and Cosmology Since 1964) Dr. Behram N. Kursunoglu, Chairman, December 14-17, 2000, Lago Mar Resort, Fort Lauderdale, FL, Kluwer Academic/Plenum Publishers, New York, pp. 243-258.
  21. R. Mills, "The Grand Unified Theory of Classical Quantum Mechanics", Int. J. Hydrogen Energy, Vol. 27, No. 5, (2002), pp. 565-590.
  17. R. Mills, "The Nature of Free Electrons in Superfluid Helium--a Test of Quantum Mechanics and a Basis to Review its Foundations and Make a Comparison to Classical Theory", Int. J. Hydrogen Energy, Vol. 26, No. 10, (2001), pp. 1059-1096.
  5. R. Mills, "The Hydrogen Atom Revisited", Int. J. of Hydrogen Energy, Vol. 25, Issue 12, December, (2000), pp. 1171-1183.
  1. R. Mills, *The Grand Unified Theory of Classical Quantum Mechanics*, September 2001 Edition, BlackLight Power, Inc., Cranbury, New Jersey, Distributed by Amazon.com; July 2003 Edition posted at [www.blacklightpower.com](http://www.blacklightpower.com).

**1. Response to argument that "Applicant's fractional hydrogen levels are postulated, not derived from first principles"**

On pages 5-6 of the Souw Appendix, the Examiner alleges that Applicant "obtained the fractional energy levels of his hypothetical hydrino, **not by deriving** from first principle(s) as claimed, but as a **postulate**. [Emphasis in original]. That allegation is unfounded. Applicant's fractional energy levels are derived --not simply "argued"--as shown below.

The derivation from Maxwell's equations for atom hydrogen states having principle energy levels given by

$$E_n = -\frac{e^2}{n^2 8 \pi \epsilon_0 a_H} = -\frac{13.598 \text{ eV}}{n^2}$$

where

$$n = \frac{1}{2}, \frac{1}{3}, \frac{1}{4}, \dots, \frac{1}{p}; \quad p \text{ is an integer; } p \leq 137$$

is given in Chps. 1-2, 5-6 of Ref. [1]:

1. R. Mills, *The Grand Unified Theory of Classical Quantum Mechanics*, September 2001 Edition, BlackLight Power, Inc., Cranbury, New Jersey, Distributed by Amazon.com; July

2003 Edition posted at [www.blacklightpower.com](http://www.blacklightpower.com).

Here it is shown that the lower-energy states are equally valid as the excited states, but require a nonradiative energy transfer to cause the transition rather than being spontaneously radiative.

## **2. Response to argument that "Applicant misunderstands all stationary atomic states are non radiative"**

Examiner Souw simply does not understand QM. The SE and Dirac equations are not electrostatic. The electron is a point particle with kinetic energy implicit in the Hamiltonian as given in QM textbooks such as McQuarrie [D. A. McQuarrie, *Quantum Chemistry*, University Science Books, Mill Valley, CA, (1983)]. In order for the electron to be stationary, it would have to be everywhere at once, traveling at infinite speed, a situation in violation of special relativity, conservation of energy, Maxwell's equations, as well as other first principles. According to the generally accepted Born interpretation of the meaning of the wavefunction, the probability of finding the electron between  $r, \theta, \phi$  and  $r + dr, \theta + d\theta, \phi + d\phi$  is given by

$$\int \Psi(r, \theta, \phi) \Psi^*(r, \theta, \phi) dr d\theta d\phi$$

The electron IS VIEWED AS A DISCRETE PARTICLE that moves here and there (from  $r = 0$  to  $r = \infty$ ), and  $\Psi\Psi^*$  gives the time average of this MOTION. The Schrödinger equation possesses terms corresponding to the electron radial and angular kinetic energy which sum with the potential energy to give the total energy. These are necessary conditions for an electron bound by a central field [H. Margenau, G. M. Murphy, *The Mathematics of Chemistry and Physics*, D. Van Nostrand Company, Inc., New York, (1956), Second Edition, pp. 363-367]. Herman Haus derived a test of radiation based on Maxwell's equations [Haus, H. A., "On the radiation from point charges", *American Journal of Physics*, 54, (1986), pp. 1126-1129]. Applying Haus's theorem to the point particle that must have radial kinetic energy demonstrates that the Schrödinger solution for the  $n = 1$  state of hydrogen is radiative; thus, it violates Maxwell's equations. Since none is observed for the  $n = 1$  state, QM is inconsistent with observation. The derivation is shown in the "Schrödinger Wave Functions in Violation of Maxwell's Equations" section of Ref. [1].

So, off course the point electron having a average trajectory given by the probability wave will radiate (taking this interpretation of  $\Psi$  among others as discussed by Laloë [F. Laloë, Do we really understand quantum mechanics? Strange correlations, paradoxes, and theorems, *Am. J. Phys.* 69 (6), June 2001, 655-701). Feynman knew this very well. He attempted to qualitatively remove the radiation using the Heisenberg Uncertainty Principle (HUP). This attempt is shown to be fatally flawed as discussed in depth in Ref. [80]. Here, it is shown that the quantum

theories of Bohr, Schrödinger, and Dirac provide no intrinsic stability of the hydrogen atom based on physics. An old argument from Feynman based on the HUP is shown to be internally inconsistent and fatally flawed. This argument further brings to light the many inconsistencies and shortcomings of QM and the intrinsic HUP that have not been reconciled from the days of their inception. The issue of stability to radiation is resolved by CQM, and the solution eliminates the mysteries and intrinsic problems of QM.

The instability of the hydrogen atom with respect to radiation according to Maxwell's equations is discussed in the following references:

94. R. L. Mills, "The Nature of the Chemical Bond Revisited and an Alternative Maxwellian Approach", J. Phys. D, submitted.
80. R. L. Mills, The Fallacy of Feynman's Argument on the Stability of the Hydrogen Atom According to Quantum Mechanics, Foundations of Physics, submitted.
58. R. L. Mills, "Classical Quantum Mechanics", Physics Essays, submitted.
53. R. Mills, "A Maxwellian Approach to Quantum Mechanics Explains the Nature of Free Electrons in Superfluid Helium", Theoretical Chemistry Accounts, submitted.
17. R. Mills, "The Nature of Free Electrons in Superfluid Helium--a Test of Quantum Mechanics and a Basis to Review its Foundations and Make a Comparison to Classical Theory", Int. J. Hydrogen Energy, Vol. 26, No. 10, (2001), pp. 1059-1096.
5. R. Mills, "The Hydrogen Atom Revisited", Int. J. of Hydrogen Energy, Vol. 25, Issue 12, December, (2000), pp. 1171-1183.
1. R. Mills, *The Grand Unified Theory of Classical Quantum Mechanics*, July 2003 Edition posted at [www.blacklightpower.com](http://www.blacklightpower.com) The Schrödinger Wavefunction in Violation of Maxwell's Equations section, Chp 35.

Also, from Weisskopf [V. F. Weisskopf, Reviews of Modern Physics, Vol. 21, No. 2, (1949), pp. 305-315], "Dirac's quantum electrodynamics gave a more consistent derivation of the results of the correspondence principle, but it also brought about a number of new and serious difficulties." Quantum electrodynamics; 1.) **does not explain nonradiation of bound electrons**; 2.) contains an internal inconsistency with special relativity regarding the classical electron radius—the electron mass corresponding to its electric energy is infinite; 3.) it admits solutions of negative rest mass and negative kinetic energy; 4.) the interaction of the electron with the predicted zero-point field fluctuations leads to infinite kinetic energy and infinite electron mass; 5.) Dirac used the unacceptable states of negative mass for the description of the vacuum; yet, infinities still arise.

The Examiner has not correctly read Applicant's theory. The excited states are predicted to be radiative as shown in Chp. 6 of Ref. [1]. The instability to radiation arises due to a radial

dipole in the spacetime Fourier transform of the current-density function of the excited state. In this case there are nonvanishing Fourier components synchronous with waves traveling at the speed of light. Thus, the states are radiative.

The radial Dirac delta function is stable in the case of an integer central field. The radiation instability is due to the field of the excited state photon at the electron as given in the Instability of Excited States section of Ref. [1]. In this case, the superposition of the field of the proton and the excited state photon is not an integer, rather it is a fraction. Then, spacetime harmonics of  $\frac{\omega_n}{c} = k$  or  $\frac{\omega_n}{c} \sqrt{\frac{\epsilon}{\epsilon_0}} = k$  do exist for which the spacetime Fourier transform of the current density function is nonzero. Thus, radiation is predicted for excited states, but not the  $n=1$  states; even though, the electron function is a radial Dirac delta function in both cases. The radiative condition based on the Fourier transform is given by

H. A. Haus, On the radiation from point charges, *American Journal of Physics*, **54**, 1126–1129 (1986)

J. Daboul and J. H. D. Jensen, *Z. Physik*, Vol. 265, (1973), pp. 455-478.

T. A. Abbott and D. J. Griffiths, *Am. J. Phys.*, Vol. 53, No. 12, (1985), pp. 1203-1211.

G. Goedecke, *Phys. Rev* 135B, (1964), p. 281.

P. Pearle, *Foundations of Physics*, "Absence of radiationless motions of relativistically rigid classical electron", Vol. 7, Nos. 11/12, (1977), pp. 931-945.

In contrast to QM, CQM derives the fully relativistic stability from Maxwell's equations as given in Chp 1 of Ref. [1] and Ref. [58].

### **3. Response to argument that "Applicant misunderstands why excited states do radiate, but the ground state do[es] not"**

Examiner Souw's dipole operator and probabilities waves does nothing to remove the instability with respect to radiation according to Maxwell's equations for a point electron moving in a central coulomb field. Furthermore, the eigenvalues and eigenfunctions are completely arbitrary as shown in the Schrödinger States Below  $n=1$  section of Ref. [17]. In this case, transitions to an infinite number of states lower than the 13.6 eV state are predicted by QM according to the Examiner's nonphysical reasoning. Furthermore, the  $n=1$  state is purely a consequence of a definition in the infinite number of solutions to the Laguerre differential equation. Neither the Schrödinger equation or the Dirac equation solve the atom correctly. The solutions are inconsistent with physical laws and numerous experimental observations as

discussed previously<sup>129</sup>.

A summary of the stability result from Maxwell's equations given in the INTRODUCTION section of Ref. [1] follows. The derivations are given in Chp. 6 of Ref. [1].

### INSTABILITY OF EXCITED STATES

For the excited (integer quantum) energy states of the hydrogen atom,  $\sigma_{\text{photon}}$ , the two-dimensional surface charge due to the "trapped photons" at the orbitsphere, is given by Eqs. (2.6) and (2.11).

$$\sigma_{\text{photon}} = \frac{e}{4\pi(r_n)^2} \left[ Y_0^0(\theta, \phi) - \frac{1}{n} \left[ Y_0^0(\theta, \phi) + \text{Re} \{ Y_l^m(\theta, \phi) e^{i\omega_n t} \} \right] \right] \delta(r - r_n) \quad n = 2, 3, 4, \dots, \quad (\text{I.59})$$

Whereas,  $\sigma_{\text{electron}}$ , the two-dimensional surface charge of the electron orbitsphere is

$$\sigma_{\text{electron}} = \frac{-e}{4\pi(r_n)^2} \left[ Y_0^0(\theta, \phi) + \text{Re} \{ Y_l^m(\theta, \phi) e^{i\omega_n t} \} \right] \delta(r - r_n) \quad (\text{I.60})$$

The superposition of  $\sigma_{\text{photon}}$  (Eq. (I.59)) and  $\sigma_{\text{electron}}$  (Eq. (I.60)), where the spherical harmonic functions satisfy the conditions given in the Angular Function section, is equivalent to the sum of a radial electric dipole represented by a doublet function and a radial electric monopole represented by a delta function.

$$\sigma_{\text{photon}} + \sigma_{\text{electron}} = \frac{e}{4\pi(r_n)^2} \left[ Y_0^0(\theta, \phi) \dot{\delta}(r - r_n) - \frac{1}{n} Y_0^0(\theta, \phi) \delta(r - r_n) - \left( 1 + \frac{1}{n} \right) \left[ \text{Re} \{ Y_l^m(\theta, \phi) e^{i\omega_n t} \} \right] \delta(r - r_n) \right] \quad n = 2, 3, 4, \dots, \quad (\text{I.61})$$

where

$$[+\delta(r - r_n) - \delta(r - r_n)] = \dot{\delta}(r - r_n) \quad (\text{I.62})$$

The Fourier transform of the current-density function that follows from the spacetime Fourier transform of Eq. (I.61), the superposition of  $\sigma_{\text{photon}}$  (Eq. (I.59)) and  $\sigma_{\text{electron}}$  (Eq. (I.60)), is

$$K(s, \Theta, \Phi, \omega) = 4\pi s_n \omega_n \frac{\cos(2s_n r_n)}{2s_n r_n} \otimes 2\pi \sum_{\nu=1}^{\infty} \frac{(-1)^{\nu-1} (\pi \sin \Theta)^{2(\nu-1)}}{(\nu-1)!(\nu-1)!} \frac{\Gamma\left(\frac{1}{2}\right) \Gamma\left(\nu + \frac{1}{2}\right)}{(\pi \cos \Theta)^{2\nu+1} 2^{\nu+1}} \frac{2\nu!}{(\nu-1)!} s^{-2\nu} \\ \otimes 2\pi \sum_{\nu=1}^{\infty} \frac{(-1)^{\nu-1} (\pi \sin \Phi)^{2(\nu-1)}}{(\nu-1)!(\nu-1)!} \frac{\Gamma\left(\frac{1}{2}\right) \Gamma\left(\nu + \frac{1}{2}\right)}{(\pi \cos \Phi)^{2\nu+1} 2^{\nu+1}} \frac{2\nu!}{(\nu-1)!} s^{-2\nu} \frac{1}{4\pi} [\delta(\omega - \omega_n) + \delta(\omega + \omega_n)] \quad (\text{I.63})$$

Consider the radial wave vector of the cosine function of Eq. (I.63). When the radial projection of the velocity is  $c$

<sup>129</sup> Reference Nos. 1, 5, 17, 53, 58, 80, 94



$$\mathbf{s}_n \bullet \mathbf{v}_n = \mathbf{s}_n \bullet \mathbf{c} = \omega_n \quad (I.64)$$

the relativistically corrected wavelength is

$$r_n = \lambda_n \quad (I.65)$$

Substitution of Eq. (I.65) into the cosine function does not result in the vanishing of the Fourier transform of the current-density function. Thus, spacetime harmonics of  $\frac{\omega_n}{c} = k$  or

$$\frac{\omega_n}{c} \sqrt{\frac{\epsilon}{\epsilon_0}} = k \text{ do exist for which the Fourier transform of the current-density function is}$$

nonzero. An excited state is metastable because it is the sum of nonradiative (stable) and radiative (unstable) components and de-excites with a transition probability given by the ratio of the power to the energy of the transition [Jackson, J. D., Classical Electrodynamics, Second Edition, John Wiley & Sons, New York, (1975), pp. 758-763].

### STABILITY OF "GROUND" AND HYDRINO STATES

For the below "ground" (fractional quantum) energy states of the hydrogen atom,  $\sigma_{\text{photon}}$ , the two-dimensional surface charge due to the "trapped photon" at the electron orbitsphere, is given by Eqs. (5.13) and (2.11).

$$\sigma_{\text{photon}} = \frac{e}{4\pi(r_n)^2} \left[ Y_0^0(\theta, \phi) - \frac{1}{n} \left[ Y_0^0(\theta, \phi) + \text{Re} \{ Y_l^m(\theta, \phi) e^{i\omega_n t} \} \right] \right] \delta(r - r_n) \quad n = 1, \frac{1}{2}, \frac{1}{3}, \frac{1}{4}, \dots, \quad (I.66)$$

And,  $\sigma_{\text{electron}}$ , the two-dimensional surface charge of the electron orbitsphere is

$$\sigma_{\text{electron}} = \frac{-e}{4\pi(r_n)^2} \left[ Y_0^0(\theta, \phi) + \text{Re} \{ Y_l^m(\theta, \phi) e^{i\omega_n t} \} \right] \delta(r - r_n) \quad (I.67)$$

The superposition of  $\sigma_{\text{photon}}$  (Eq. (I.66)) and  $\sigma_{\text{electron}}$ , (Eq. (I.67)) where the spherical harmonic functions satisfy the conditions given in the Angular Function section is a radial electric monopole represented by a delta function.

$$\sigma_{\text{photon}} + \sigma_{\text{electron}} = \frac{-e}{4\pi(r_n)^2} \left[ \frac{1}{n} Y_0^0(\theta, \phi) + \left( 1 + \frac{1}{n} \right) \text{Re} \{ Y_l^m(\theta, \phi) e^{i\omega_n t} \} \right] \delta(r - r_n) \quad n = 1, \frac{1}{2}, \frac{1}{3}, \frac{1}{4}, \dots, \quad (I.68)$$

As given in the Spacetime Fourier Transform of the Electron Function section of Ref. [1], the radial delta function does not possess spacetime Fourier components synchronous with waves traveling at the speed of light (Eqs. (I.19-I.21)). Thus, the below "ground" (fractional quantum) energy states of the hydrogen atom are stable. The "ground" ( $n = 1$  quantum) energy state is just the first of the nonradiative states of the hydrogen atom; thus, it is the state to which excited states decay.

A summary of the stability derivation based on the Haus condition given in Chp. 1 of Ref.

[1] is

### Nonradiation Based on the Spacetime Fourier Transform of the Electron Current

Although an accelerated *point* particle radiates, an *extended distribution* modeled as a superposition of accelerating charges does not have to radiate. The spacetime Fourier transform of the current-density function is

$$K(s, \Theta, \Phi, \omega) = 4\pi\omega_n \frac{\sin(2sr_n)}{2sr_n} \otimes 2\pi \sum_{\nu=1}^{\infty} \frac{(-1)^{\nu-1} (\pi \sin \Theta)^{2(\nu-1)}}{(\nu-1)!(\nu-1)!} \frac{\Gamma\left(\frac{1}{2}\right) \Gamma\left(\nu + \frac{1}{2}\right)}{(\pi \cos \Theta)^{2\nu+1} 2^{\nu+1}} \frac{2\nu!}{(\nu-1)!} s^{-2\nu}$$

$$\otimes 2\pi \sum_{\nu=1}^{\infty} \frac{(-1)^{\nu-1} (\pi \sin \Phi)^{2(\nu-1)}}{(\nu-1)!(\nu-1)!} \frac{\Gamma\left(\frac{1}{2}\right) \Gamma\left(\nu + \frac{1}{2}\right)}{(\pi \cos \Phi)^{2\nu+1} 2^{\nu+1}} \frac{2\nu!}{(\nu-1)!} s^{-2\nu} \frac{1}{4\pi} [\delta(\omega - \omega_n) + \delta(\omega + \omega_n)]$$

$$\mathbf{s}_n \bullet \mathbf{v}_n = \mathbf{s}_n \bullet \mathbf{c} = \omega_n$$

The relativistically corrected wavelength is

$$\lambda_n = r_n$$

Spacetime harmonics of  $\frac{\omega_n}{c} = k$  or  $\frac{\omega_n}{c} \sqrt{\frac{\epsilon}{\epsilon_0}}$  for which the Fourier transform of the current-density

function is nonzero do not exist. Radiation due to charge motion does not occur in any medium when this condition is met.

Haus, H. A., "On the radiation from point charges", American Journal of Physics, 54, (1986), pp. 1126-1129.

Abbott, T. A., Griffiths, D. J., Am. J. Phys., Vol. 153, No. 12, (1985), pp. 1203-1211.

G. Goedecke, Phys. Rev 135B, (1964), p. 281.

A summary of the stability derivation based on the Poynting Power Vector given in Chp. 1, Appendix I of Ref. [1] is

### Nonradiation Based on the Electron Electromagnetic Fields and the Poynting Power Vector

Although an accelerated *point* particle radiates, an *extended distribution* modeled as a superposition of accelerating charges does not have to radiate. The general multipole field solution to Maxwell's equations in a source-free region of empty space with the assumption of a time dependence  $e^{i\omega_n t}$  is

$$\begin{aligned} \mathbf{B} &= \sum_{\ell, m} \left[ a_E(\ell, m) f_\ell(kr) \mathbf{X}_{\ell, m} - \frac{i}{k} a_M(\ell, m) \nabla \times g_\ell(kr) \mathbf{X}_{\ell, m} \right] \\ \mathbf{E} &= \sum_{\ell, m} \left[ \frac{i}{k} a_E(\ell, m) \nabla \times f_\ell(kr) \mathbf{X}_{\ell, m} + a_M(\ell, m) g_\ell(kr) \mathbf{X}_{\ell, m} \right] \end{aligned} \quad (1)$$

For the electron source current comprising a multipole of order  $(\ell, m)$ , the far fields are given by

$$\begin{aligned} \mathbf{B} &= -\frac{i}{k} a_M(\ell, m) \nabla \times g_\ell(kr) \mathbf{X}_{\ell, m} \\ \mathbf{E} &= a_M(\ell, m) g_\ell(kr) \mathbf{X}_{\ell, m} \end{aligned} \quad (2)$$

and the time-averaged power radiated per solid angle  $\frac{dP(\ell, m)}{d\Omega}$  is

$$\frac{dP(\ell, m)}{d\Omega} = \frac{c}{8\pi k^2} |a_M(\ell, m)|^2 |\mathbf{X}_{\ell, m}|^2 \quad (3)$$

where  $a_M(\ell, m)$  is

$$a_M(\ell, m) = \frac{-ek^2}{c\sqrt{\ell(\ell+1)}} \frac{\omega_n}{2\pi} N_{j_\ell}(kr_n) \Theta \sin(mks) \quad (4)$$

In the case that  $k$  is the lightlike  $k^0$ , then  $k = \omega_n / c$ , in Eq. (4), and Eqs. (2-3) vanishes for

$$s = vT_n = R = r_n = \lambda_n \quad (5)$$

There is no radiation.

#### 4. Response to argument that "Applicant misunderstands the most basic fundamentals of the QM theory"

Applicant rejects the Schrödinger equation (SE). There is no a priori basis for the SE to be the CORRECT equation of nature. In fact it is not even a true wave equation. In this case, the electron velocity is proportional to the frequency squared; consequently, energy and momentum are not conserved for an inverse-squared central Coulombic force as required. There are many other problems beside infinities, instability with respect to radiation according to Maxwell's equations, and the failure to predict spin as discussed previously<sup>130</sup>.

The nonradiation boundary condition of the atom requires that the electron be a solution of the two-dimensional wave equation plus time. The derivation is given in the Spacetime Fourier Transform of the Electron Function section and the Angular Function section of Ref. [1] and Ref. [58]. There is no a priori basis why the electron can not obey this wave equation versus

<sup>130</sup> Reference Nos. 1, 5, 17, 53, 58, 80, 94

one based on a three-dimensions plus time. The subsequent results given in references <sup>131</sup>are remarkably accurate when compared to the corresponding observed values. Thus, the Examiner's position that the radial Dirac delta function must be a solution of the three-dimensional wave equation is irrelevant.

Applicant's angular functions are solutions of the wave equation as shown in BOX 1.1. DERIVATION OF THE ROTATIONAL PARAMETERS OF THE ELECTRON FROM A SPECIAL CASE OF THE WAVE EQUATION—THE RIGID ROTOR EQUATION of Ref. [1]. The fully relativistic result is stable with respect to radiation and matches the spectrum of hydrogen to the limit of experimental measurement including the electron g factor, fine structure, and Lamb shift as shown in Chps. 1 and 2 of Ref [1].

Applicant's approach starts with first principles rather than a postulated equation having probability-wave solutions which have no basis in reality<sup>132</sup>. A summary of Applicant's approach is given in the INTRODUCTION section of Ref [1] and the derivation is given in Chp. 1 of Ref. [1]. A further summary is given in Ref. [58] that follows wherein the reference numbers correspond to those in this journal article:

### ONE-ELECTRON ATOMS

One-electron atoms include the hydrogen atom,  $He^+$ ,  $Li^{2+}$ ,  $Be^{3+}$ , and so on. The mass-energy and angular momentum of the electron are constant; this requires that the equation of motion of the electron be temporally and spatially harmonic. Thus, the classical wave equation applies and

$$\left[ \nabla^2 - \frac{1}{v^2} \frac{\partial^2}{\partial t^2} \right] \rho(r, \theta, \phi, t) = 0 \quad (2)$$

where  $\rho(r, \theta, \phi, t)$  is the time dependent charge density function of the electron in time and space. In general, the wave equation has an infinite number of solutions. To arrive at the solution which represents the electron, a suitable boundary condition must be imposed. It is well known from experiments that each single atomic electron of a given isotope radiates to the same stable state. Thus, the physical boundary condition of nonradiation of the bound electron was imposed on the solution of the wave equation for the time dependent charge density function of the electron [1]. The condition for radiation by a moving point charge given by Haus [10] is that its spacetime Fourier transform does possess components that are synchronous with waves traveling at the speed of light. Conversely, it is proposed that the condition for nonradiation by an ensemble of moving point charges that comprises a current

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<sup>131</sup> Reference Nos. 1, 5, 17, 53, 58, 80, 94

<sup>132</sup> Reference Nos. 1, 5, 17, 53, 58, 80, 94

density function is

*For non-radiative states, the current-density function must NOT possess spacetime Fourier components that are synchronous with waves traveling at the speed of light.*

The time, radial, and angular solutions of the wave equation are separable. The motion is time harmonic with frequency  $\omega_n$ . A constant angular function is a solution to the wave equation. Solutions of the Schrödinger wave equation comprising a radial function radiate according to Maxwell's equation as shown previously by application of Haus' condition [1]. In fact, it was found that any function which permitted radial motion gave rise to radiation. A radial function which does satisfy the boundary condition is a radial delta function

$$f(r) = \frac{1}{r^2} \delta(r - r_n) \quad (3)$$

This function defines a constant charge density on a spherical shell where  $r_n = nr_1$  wherein  $n$  is an integer in an excited state as given in the Excited States section, and Eq. (2) becomes the two-dimensional wave equation plus time with separable time and angular functions. Given time harmonic motion and a radial delta function, the relationship between an allowed radius and the electron wavelength is given by

$$2\pi r_n = \lambda_n \quad (4)$$

where the subscript  $n$  is determined during photon absorption as given by Eq. (83). Using the observed de Broglie relationship for the electron mass where the coordinates are spherical,

$$\lambda_n = \frac{h}{p_n} = \frac{h}{m_e v_n} \quad (5)$$

and the magnitude of the velocity for every point on the orbitsphere is

$$v_n = \frac{\hbar}{m_e r_n} \quad (6)$$

The sum of the  $|\mathbf{L}_i|$ , the magnitude of the angular momentum of each infinitesimal point of the orbitsphere of mass  $m_i$ , must be constant. The constant is  $\hbar$ .

$$\sum |\mathbf{L}_i| = \sum |\mathbf{r} \times m_i \mathbf{v}| = m_e r_n \frac{\hbar}{m_e r_n} = \hbar \quad (7)$$

Thus, an electron is a spinning, two-dimensional spherical surface (zero thickness), called an *electron orbitsphere*, that can exist in a bound state at only specified distances from the nucleus as shown in Figure 1. The corresponding current function shown in Figure 2 which gives rise to the phenomenon of *spin* is derived in the "Spin Function" section. (See the Appendix and the Orbitsphere Equation of Motion for  $\ell = 0$  of Ref. [1] at Chp. 1.)

Nonconstant functions are also solutions for the angular functions. To be a harmonic

solution of the wave equation in spherical coordinates, these angular functions must be spherical harmonic functions [13]. A zero of the spacetime Fourier transform of the product function of two spherical harmonic angular functions, a time harmonic function, and an unknown radial function is sought. The solution for the radial function which satisfies the boundary condition is also a delta function given by Eq. (3). Thus, bound electrons are described by a charge-density (mass-density) function which is the product of a radial delta function, two angular functions (spherical harmonic functions), and a time harmonic function.

$$\rho(r, \theta, \phi, t) = f(r)A(\theta, \phi, t) = \frac{1}{r^2} \delta(r - r_n)A(\theta, \phi, t); \quad A(\theta, \phi, t) = Y(\theta, \phi)k(t) \quad (8)$$

In these cases, the spherical harmonic functions correspond to a traveling charge density wave confined to the spherical shell which gives rise to the phenomenon of orbital angular momentum. The orbital functions which modulate the constant "spin" function shown graphically in Figure 3 are given in the "Angular Functions" section.

The hydrogen molecule is also solved using the nonradiative boundary condition as given in Chp. 12 of Ref. [1] and in Ref. [94], 94. R. L. Mills, "The Nature of the Chemical Bond Revisited and an Alternative Maxwellian Approach", J. Phys. D, submitted. Here, there is also no a priori reason why the electron must be a solution of the three dimensional wave equation plus time and can not obey a two dimensional wave equation plus time. Furthermore, in addition to the important result of stability to radiation, several more very important physical results are subsequently realized: 1.) The charge is distributed on a two dimension surface; thus, there is no infinities in the corresponding fields. Infinite fields are simply renormalized in the case of the point-particles of quantum mechanics, but it is physically gratifying that none arise in this case since infinite fields have never been measured or realized in the laboratory. 2.) The hydrogen molecular ion or molecule has finite dimensions rather than extending over all space. From measurements of the resistivity of hydrogen as a function of pressure, the finite dimensions of the hydrogen molecule are evident in the plateau of the resistivity versus pressure curve of metallic hydrogen [W. J. Nellis, "Making Metallic Hydrogen", Scientific American, May, (2000), pp. 84-90]. This is in contradiction to the predictions of quantum probability functions such as an exponential radial distribution in space. 3.) Consistent with experiments, neutral scattering is predicted without violation of special relativity wherein a point must be everywhere at once as required in the QM case. 4.) There is no electron self interaction. The continuous charge-density function is a two-dimensional equipotential energy surface with an electric field that is strictly normal for the elliptic parameter  $\xi > 0$  (See Sec. III.) according to Gauss' law and Faraday's law. The relationship between the electric field equation and the electron source charge-density

function is given by Maxwell's equation in two dimensions [J. A. Stratton, *Electromagnetic Theory*, McGraw-Hill Book Company, (1941), p. 195; J. D. Jackson, *Classical Electrodynamics*, Second Edition, John Wiley & Sons, New York, (1975), pp. 17-22].

$$\mathbf{n} \cdot (\mathbf{E}_1 - \mathbf{E}_2) = \frac{\sigma}{\epsilon_0} \quad (12)$$

where  $\mathbf{n}$  is the normal unit vector,  $\mathbf{E}_1 = 0$  ( $\mathbf{E}_1$  is the electric field inside of the MO),  $\mathbf{E}_2$  is the electric field outside of the MO and  $\sigma$  is the surface charge density. This relation shows that only a two-dimensional geometry meets the criterion for a fundamental particle. This is the nonsingularity geometry which is no longer divisible. It is the dimension from which it is not possible to lower dimensionality. In this case, there is no electrostatic self interaction since the corresponding potential is continuous across the surface according to Faraday's law in the electrostatic limit, and the field is discontinuous, normal to the charge according to Gauss' law [J. A. Stratton, *Electromagnetic Theory*, McGraw-Hill Book Company, (1941), p. 195; J. D. Jackson, *Classical Electrodynamics*, Second Edition, John Wiley & Sons, New York, (1975), pp. 17-22; H. A. Haus, J. R. Melcher, "Electromagnetic Fields and Energy", Department of Electrical engineering and Computer Science, Massachusetts Institute of Technology, (1985), Sec. 5.3]. 5.) The instability of electron-electron repulsion of molecular hydrogen is eliminated since the central field of the hydrogen molecular ion relative to a second electron at  $\xi > 0$  which binds to form the hydrogen molecule is that of a single charge at the foci. 6.) The ellipsoidal MO's allow exact spin pairing over all time which is consistent with experimental observation. This aspect is not possible in the QM model. And, 7.) The ellipsoidal MO's allow for the basis of excited states as fully Maxwellian compliant resonator mode excitations and for the ionization of the electron as a plane wave with the  $\hbar$  of angular momentum conserved corresponding to the de Broglie wavelength. Physical predictions match the wave-particle duality nature of the free electron as shown in the Electron in Free Space section of Ref [1].

As given previously<sup>133</sup>, a proposed solution based on physical laws and fully compliant with Maxwell's equations solves the parameters of molecular ions and molecules of hydrogen isotopes from the Laplacian in elliptic coordinates in closed form equations with fundamental constants only. The boundary condition of nonradiation requires that the electron be a solution of the two-dimensional wave equation plus time. There is no a priori basis why the electron can not obey this wave equation versus one based on three dimensions plus time. The corresponding Dirac delta function in the elliptic parameter  $\xi$  gives the physical representation of the bound electron as a two dimensional equipotential surface of charge (mass) density with time-harmonic motion along a geodesic at each position on the surface. The electron molecular orbitals in this

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<sup>133</sup> Reference No. 94

case that do not depend on an exchange integral are truly physical rather than purely mathematical. The closed form solutions of  $H_2^+$ ,  $D_2^+$ ,  $H_2$ , and  $D_2$  given in Table 1 show that hydrogen species can be solved in closed form with tremendous accuracy using first principles.

The observed  $\sqrt{\frac{k}{\mu}}$  dependency of vibrational energies on the isotope is obtained without the requirement of any imaginary (experimentally not observed ) zero-point vibration.



Table 1:

**The calculated and experimental parameters of  $H_2$ ,  $D_2$ ,  $H_2^+$  and  $D_2^+$ .**

Parameter	Calculated	Experimental	Eqs. <sup>a</sup>
$H_2$ Bond Energy	4.478 eV	4.478 eV	12.238
$D_2$ Bond Energy	4.556 eV	4.556 eV	12.240
$H_2^+$ Bond Energy	2.654 eV	2.651 eV	12.211
$D_2^+$ Bond Energy	2.696 eV	2.691 eV	12.213
$H_2$ Total Energy	31.677 eV	31.675 eV	12.234
$D_2$ Total Energy	31.760 eV	31.760 eV	12.235
$H_2$ Ionization Energy	15.425 eV	15.426 eV	12.236
$D_2$ Ionization Energy	15.463 eV	15.466 eV	12.237
$H_2^+$ Ionization Energy	16.253 eV	16.250 eV	12.209
$D_2^+$ Ionization Energy	16.299 eV	16.294 eV	12.210
$H_2$ Magnetic Moment	$9.274 \times 10^{-24} \text{ JT}^{-1}$	$9.274 \times 10^{-24} \text{ JT}^{-1}$	14.1-14.7
Absolute $H_2$ Gas-Phase NMR Shift	$\mu_B$ -28.0 ppm	$\mu_B$ -28.0 ppm	12.367
$H_2$ Internuclear Distance <sup>b</sup>	0.748 Å $\sqrt{2}a_o$	0.741 Å	12.225
$D_2$ Internuclear Distance <sup>b</sup>	0.748 Å $\sqrt{2}a_o$	0.741 Å	12.225
$H_2^+$ Internuclear Distance <sup>c</sup>	1.058 Å $2a_o$	1.06 Å	12.198
$D_2^+$ Internuclear Distance <sup>b</sup>	1.058 Å $2a_o$	1.0559 Å	12.198
$H_2$ Vibrational Energy	0.517 eV	0.516 eV	12.246
$D_2$ Vibrational Energy	0.371 eV	0.371 eV	12.248
$H_2^+$ Vibrational Energy	0.270 eV	0.271 eV	12.219
$D_2^+$ Vibrational Energy	0.193 eV	0.196 eV	12.221
$H_2$ J=1 to J=0 Rotational Energy <sup>b</sup>	0.0148 eV	0.01509 eV	14.43
$D_2$ J=1 to J=0 Rotational Energy <sup>b</sup>	0.00741 eV	0.00755 eV	14.35-14.43
$H_2^+$ J=1 to J=0 Rotational Energy <sup>c</sup>	0.00740 eV	0.00739 eV	14.47
$D_2^+$ J=1 to J=0 Rotational Energy <sup>b</sup>	0.00370 eV	0.003723 eV	14.35-14.41, 14.47

<sup>a</sup> R. Mills, *The Grand Unified Theory of Classical Quantum Mechanics*, July 2003 Edition, BlackLight Power, Inc., Cranbury, New Jersey, posted at [www.blacklightpower.com](http://www.blacklightpower.com).

<sup>b</sup> The internuclear distances are not corrected for the reduction due to  $\bar{E}_{osc}$ .

<sup>c</sup> The internuclear distances are not corrected for the increase due to  $\bar{E}_{osc}$ .

### 5. Response to argument that "Applicant is mistaken in understanding and applying Haus's nonradiative condition"

The Examiner is mistaken in his understanding of  $\rho(r, t)$ . This is the charge as a function of space and time which gives the current. That is, a time dependent charge corresponds to a current.

From the SPACETIME FOURIER TRANSFORM OF THE ELECTRON FUNCTION section of Chp. 1 of Ref. [1] were the references correspond to those in the reference:

Therefore, the spacetime Fourier transform,  $M(s, \Theta, \Phi, \omega)$ , is the convolution of Eqs. (1.11), (1.35), (1.36), and (1.37).

$$M(s, \Theta, \Phi, \omega) = 4\pi \text{sinc}(2sr_n) \otimes 2\pi \sum_{\nu=1}^{\infty} \frac{(-1)^{\nu-1} (\pi \sin \Theta)^{2(\nu-1)}}{(\nu-1)!(\nu-1)!} \frac{\Gamma\left(\frac{1}{2}\right) \Gamma\left(\nu + \frac{1}{2}\right)}{(\pi \cos \Theta)^{2\nu+1} 2^{\nu+1}} \frac{2\nu!}{(\nu-1)!} s^{-2\nu} \\ \otimes 2\pi \sum_{\nu=1}^{\infty} \frac{(-1)^{\nu-1} (\pi \sin \Phi)^{2(\nu-1)}}{(\nu-1)!(\nu-1)!} \frac{\Gamma\left(\frac{1}{2}\right) \Gamma\left(\nu + \frac{1}{2}\right)}{(\pi \cos \Phi)^{2\nu+1} 2^{\nu+1}} \frac{2\nu!}{(\nu-1)!} s^{-2\nu} \frac{1}{4\pi} [\delta(\omega - \omega_n) + \delta(\omega + \omega_n)] \quad (1.39)$$

The condition for nonradiation of a moving charge-density function is that the spacetime Fourier transform of the **current-density function** must not have waves synchronous with waves traveling at the speed of light, that is synchronous with  $\frac{\omega_n}{c}$  or synchronous with

$\frac{\omega_n}{c} \sqrt{\frac{\epsilon}{\epsilon_0}}$  where  $\epsilon$  is the dielectric constant of the medium. The Fourier transform of the

charge-density function of the orbitsphere (bubble of radius  $r$ ) is given by Eq. (1.39). In the case of time harmonic motion, the **current-density function** is given by the time derivative of the charge-density function. Thus, the **current-density function** is given by the product of the constant angular velocity and the charge-density function. The Fourier transform of the **current-density function** of the orbitsphere is given by the product of the constant angular velocity and Eq. (1.39). Consider the radial and time parts of,  $K_{\perp}$ , the Fourier transform of the current-density function where the angular transforms are not zero:

$$K(s, \Theta, \Phi, \omega) = 4\pi \omega_n \frac{\sin(2sr_n)}{2sr_n} \otimes 2\pi \sum_{\nu=1}^{\infty} \frac{(-1)^{\nu-1} (\pi \sin \Theta)^{2(\nu-1)}}{(\nu-1)!(\nu-1)!} \frac{\Gamma\left(\frac{1}{2}\right) \Gamma\left(\nu + \frac{1}{2}\right)}{(\pi \cos \Theta)^{2\nu+1} 2^{\nu+1}} \frac{2\nu!}{(\nu-1)!} s^{-2\nu} \\ \otimes 2\pi \sum_{\nu=1}^{\infty} \frac{(-1)^{\nu-1} (\pi \sin \Phi)^{2(\nu-1)}}{(\nu-1)!(\nu-1)!} \frac{\Gamma\left(\frac{1}{2}\right) \Gamma\left(\nu + \frac{1}{2}\right)}{(\pi \cos \Phi)^{2\nu+1} 2^{\nu+1}} \frac{2\nu!}{(\nu-1)!} s^{-2\nu} \frac{1}{4\pi} [\delta(\omega - \omega_n) + \delta(\omega + \omega_n)] \quad (1.40)$$

For the case that the **current-density function** is constant, the delta function of Eq. (1.40) is replaced by a constant. For time harmonic motion, with angular velocity,  $\omega_n$ , Eq. (1.40) is nonzero only for  $\omega = \omega_n$ ; thus,  $-\infty < s < \infty$  becomes finite only for the corresponding wavenumber,  $s_n$ . The relationship between the radius and the wavelength is

$$v_n = \lambda_n f_n \quad (1.41)$$

$$v_n = 2\pi r_n f_n = \lambda_n f_n \quad (1.42)$$

$$2\pi r_n = \lambda_n \quad (1.43)$$

The motion on the orbitsphere is angular; however, a radial component exists due to Special Relativistic effects. Consider the radial wave vector of the sinc function. When the radial projection of the velocity is  $c$

$$\mathbf{s}_n \bullet \mathbf{v}_n = \mathbf{s}_n \bullet \mathbf{c} = \omega_n \quad (1.44)$$

the relativistically corrected wavelength is

$$\lambda_n = r_n \quad (1.45)$$

(i.e. the lab frame motion in the angular direction goes to zero as the velocity approaches the speed of light as given by Eq. (24.15)). The charge-density functions in spherical coordinates plus time are given by Eqs. (1.64-1.65). In the case of Eq. (1.64), the wavelength of Eq. (1.44) is independent of  $\theta$ ; whereas, in the case of Eq. (1.65), the wavelength in Eq. (1.44) is a function of  $\sin \theta$ . Thus, in the latter case, Eq. (1.45) holds wherein the relationship of wavelength and the radius as a function of  $\theta$  are given by  $r_n \sin \theta = \lambda_n \sin \theta$ .

The equipotential, uniform or constant charge-density function (Eq. (1.64)) further comprises a **current pattern** given in the ORBITSPHERE EQUATION OF MOTION FOR  $\ell = 0$  section and corresponds to the spin function of the electron. It also corresponds to the nonradiative  $n = 1, \ell = 0$  state of atomic hydrogen. There is acceleration without radiation. In this case, centripetal acceleration. A static charge distribution exists even though each point on the surface is accelerating along a great circle. Haus' condition predicts no radiation for the entire ensemble.

In cases of orbitals of heavier elements and excited states of one electron atoms and atoms or ions of heavier elements which are not constant as given by Eq. (1.65), the constant spin function is modulated by a time and spherical harmonic function. The modulation or traveling charge-density wave corresponds to an orbital angular momentum in addition to a spin angular momentum. These states are typically referred to as p, d, f, etc. orbitals and correspond to an  $\ell$  quantum number not equal to zero. Haus' condition also predicts nonradiation for a constant spin function modulated by a time and spherically harmonic orbital function. However, in the case that such a state arises as an excited state by photon absorption, it is radiative due to a radial dipole term in its **current-density function** since it possesses spacetime Fourier transform components synchronous with waves traveling at the

speed of light as given in the INSTABILITY OF EXCITED STATES section.

Substitution of Eq. (1.45) into the sinc function results in the vanishing of the entire Fourier transform of the **current-density function**. Thus, spacetime harmonics of  $\frac{\omega_n}{c} = k$  or  $\frac{\omega_n}{c} \sqrt{\frac{\epsilon}{\epsilon_0}} = k$  do not exist for which the Fourier transform of the **current-density function** is nonzero. Radiation due to charge motion does not occur in any medium when this boundary condition is met. Note that the boundary condition for the solution of the radial function of the hydrogen atom with the Schrödinger equation is that  $\Psi \rightarrow 0$  as  $r \rightarrow \infty$ . Here, however, the boundary condition is derived from Maxwell's equations: For non-radiative states, the **current-density function** must not possess spacetime Fourier components that are synchronous with waves traveling at the speed of light. An alternative derivation which provides acceleration without radiation is given by Abbott <sup>134</sup> Bound electrons are described by a charge-density (mass-density) function which is the product of a radial delta function, Eq. (1.3), two angular functions (spherical harmonic functions), and a time harmonic function. This is a solution of Laplace's Equation. Thus, this radial function implies that allowed states are two-dimensional spherical shells (zero thickness) of charge density (and mass density) at specific radii  $r_n$ . These shells are referred to as electron orbitspheres. See Figure 1.1 for a pictorial representation of an orbitsphere.

In addition to demonstrating that Applicant's theory correctly provides for stability of the  $n=1$  state of the hydrogen atom after Haus [Haus, H. A., "On the radiation from point charges", American Journal of Physics, 54, (1986), pp. 1126-1129] and also after others [Abbott, T. A., Griffiths, D. J., Am. J. Phys., Vol. 153, No. 12, (1985), pp. 1203-1211; G. Goedecke, Phys. Rev 135B, (1964), p. 281], Applicant shows that the electron solutions are stable according to the Poynting Power Vector derived from the **current-density functions** as given in Appendix I of Ref. [1]. A summary follows:

### **Nonradiation Based on the Electron Electromagnetic Fields and the Poynting Power Vector**

The general multipole field solution to Maxwell's equations in a source-free region of empty space with the assumption of a time dependence  $e^{i\omega_n t}$  is

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<sup>134</sup> Reference No. 11

$$\begin{aligned} \mathbf{B} &= \sum_{\ell, m} \left[ a_E(\ell, m) f_\ell(kr) \mathbf{X}_{\ell, m} - \frac{i}{k} a_M(\ell, m) \nabla \times g_\ell(kr) \mathbf{X}_{\ell, m} \right] \\ \mathbf{E} &= \sum_{\ell, m} \left[ \frac{i}{k} a_E(\ell, m) \nabla \times f_\ell(kr) \mathbf{X}_{\ell, m} + a_M(\ell, m) g_\ell(kr) \mathbf{X}_{\ell, m} \right] \end{aligned} \quad (1)$$

For the electron source current comprising a multipole of order  $(\ell, m)$ , the far fields are given by

$$\begin{aligned} \mathbf{B} &= -\frac{i}{k} a_M(\ell, m) \nabla \times g_\ell(kr) \mathbf{X}_{\ell, m} \\ \mathbf{E} &= a_M(\ell, m) g_\ell(kr) \mathbf{X}_{\ell, m} \end{aligned} \quad (2)$$

and the time-averaged power radiated per solid angle  $\frac{dP(\ell, m)}{d\Omega}$  is

$$\frac{dP(\ell, m)}{d\Omega} = \frac{c}{8\pi k^2} |a_M(\ell, m)|^2 |\mathbf{X}_{\ell, m}|^2 \quad (3)$$

where  $a_M(\ell, m)$  is

$$a_M(\ell, m) = \frac{-ek^2}{c\sqrt{\ell(\ell+1)}} \frac{\omega_n}{2\pi} Nj_\ell(kr_n) \Theta \sin(mks) \quad (4)$$

In the case that  $k$  is the lightlike  $k^0$ , then  $k = \omega_n / c$ , in Eq. (4), and Eqs. (2-3) vanishes for

$$s = vT_n = R = r_n = \lambda_n \quad (5)$$

*There is no radiation.*

Of course, the QM solutions are not stable with respect to radiation and violate Maxwell's equations as discussed in Chp. 35 of Ref. [1] and elsewhere<sup>135</sup>.

##### 5. (repeated) Response to argument that "Applicant is confusing QM eigenfunction with QM wave equation"

Applicant solves the spin and orbital angular momenta and energies physically rather than purely mathematically. The distinction between an eigenfunction and a "wavefunction comprised of eigenfunctions" for the solution of the bound electron is due entirely to a mathematical postulate of QM. It has no basis in physics and in fact leads to consequences that are not physically tenable as shown *infra*. In the CQM solutions, the constant function integrates to the charge of an electron and the modulation function integrates to zero where the functions are charge and current density-functions rather than probability waves. They are not squared as required in QM. They are not required to yield the Kroenecker delta as they are in the case of QM. This is a nonphysical and nonsensical consequence of QM since  $\Psi$  as a probability wave has no basis in reality as discussed previously in Ref. [1, 5, 17, 21, 22, 53, 58, 80, 94] and by Laloë [F. Laloë, Do we really understand quantum mechanics? Strange correlations, paradoxes, and theorems, Am. J. Phys. 69 (6), June 2001, 655-701]. Furthermore, the Examiner's

<sup>135</sup> Reference Nos. 1, 5, 17, 21, 22, 53, 58, 80, 94

requirement of taking linear combinations of eigenfunctions to result in a "wavefunction" solution to avoid violating the Uncertainty Principle is internally inconsistent with Examiner's point # 6 wherein the Examiner claims the SE spherical harmonic solutions can not be linear combinations since the Kroenecker delta is not obtained as required since the probability density functions must be squared.

The orbital energy of  $Y_0^0(\theta, \phi)$  is zero, but the spin energy is given by Eq. (1.82) of Ref. [1]. The orbital energy of  $Y_l^m(\theta, \phi)$  has a magnitude given by Eq. (1.95) of Ref. [1] that has a time average of zero since it comprises a spherical and time-harmonic modulation wave of the constant spin function as given by Eq. (1.98) of Ref. [1]. The results agree with experimental observations as shown in Chp. 1 and 2 of Ref. [1]. (Also see #7 of this Response.)

The QM approach outlined by the Examiner can further be showed to be fatally flawed. For example, as discussed in Ref. [80] for  $n = 1$ ,  $\ell = 0$ ; thus,  $K_{rot}$  is zero which is impossible since the kinetic energy is  $\frac{\hbar^2}{2mr^2}$ :

2.) Eq. (3) follows from the Schrödinger equation, not the Bohr theory. In the time independent Schrödinger equation, the kinetic energy of rotation  $K_{rot}$  is given by [H. Margenau, G. M. Murphy, *The Mathematics of Chemistry and Physics*, D. Van Nostrand Company, Inc., New York, (1956), Second Edition, pp. 363-367]

$$K_{rot} = \frac{\ell(\ell+1)\hbar^2}{2mr^2} \quad (11)$$

where

$$L = \sqrt{\ell(\ell+1)}\hbar \quad (12)$$

is the value of the electron angular momentum  $L$  for the state  $Y_{lm}(\theta, \phi)$ <sup>136</sup>. For the  $n=1$  state,  $\ell = 0$ ; thus, **the angular momentum according to the Schrödinger equation is exactly zero—**

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<sup>136</sup> At page 365 Margenau and Murphy [H. Margenau, G. M. Murphy, *The Mathematics of Chemistry and Physics*, D. Van Nostrand Company, Inc., New York, (1956), Second Edition, pp. 363-367] state

" but with the term  $\frac{\ell(\ell+1)\hbar^2}{2mr^2}$  added to the normal potential energy. What is the meaning of that term? In classical mechanics, the energy of a particle moving in three dimensions differs from that of a one-dimensional particle by the kinetic energy of rotation,  $\frac{1}{2}mr^2\omega^2$ . This is precisely the quantity  $\frac{\ell(\ell+1)\hbar^2}{2mr^2}$ , for we have seen that  $\ell(\ell+1)\hbar^2$  is the *certain* value of the square of the angular momentum for the state  $Y_l$ , in classical language  $(mr^2\omega^2)^2$  which is divided by  $2mr^2$ , gives exactly the kinetic energy of rotation."

not  $\hbar$ . Furthermore, the kinetic energy of rotation  $K_{rot}$  is also **zero**. As a consequence, it is internally inconsistent for Feynman to accept the HUP which arises from the Schrödinger equation on the one hand and that the electron obeys the classical Coulomb law and is bound in an inverse squared Coulomb field on the other. Rather than a kinetic energy of  $\frac{\hbar^2}{2mr^2}$  which is added to the Coulomb energy of  $-\frac{e^2}{r}$  to get the total energy, exactly zero should be added to the Coulomb energy. This is an inescapable nonsensical result which arises from the SE directly, and it can not be saved by incorrectly assigning the angular momentum as  $\hbar$  from the uncertainty relationship. Furthermore, the result that  $L = K_{rot} = \text{exactly zero}$  violates the HUP making the argument further internally inconsistent.

Further nonsensical results arise for the purely mathematical approach of QM promoted by the Examiner. From Ref. [17]:

For the Schrödinger equation, the kinetic energy of rotation  $K_{rot}$  is given by

$$K_{rot} = \frac{\ell(\ell+1)\hbar^2}{2mr^2} \quad (10)$$

where

$$L = \sqrt{\ell(\ell+1)}\hbar \quad (11)$$

is the value of the electron angular momentum  $L$  for the state  $Y_{lm}(\theta, \phi)$ .

### The POSTULATED Schrödinger Equation Fails to Solve the Hydrogen Atom Correctly.

- In the time independent Schrödinger equation, the kinetic energy of rotation  $K_{rot}$  is given by Eq. (10) where the value of the electron angular momentum  $L$  for the state  $Y_{lm}(\theta, \phi)$  is given by Eq. (11). The Schrödinger equation solutions, Eq. (10) and Eq. (11), predict that the ground state electron has zero angular energy and zero angular momentum, respectively.

- The Schrödinger equation solution, Eq. (11), predicts that the ionized electron may have infinite angular momentum.

- The Schrödinger equation solutions, Eq. (10) and Eq. (11), predict that the excited state rotational energy levels are nondegenerate as a function of the  $\ell$  quantum number even in the absence of an applied magnetic field, and the predicted energy is over six orders of

magnitude of the observed nondegenerate energy in the presence of a magnetic field. In the absence of a magnetic field, no preferred direction exists. In this case, the  $\ell$  quantum number is a function of the orientation of the atom with respect to an arbitrary coordinate system. Therefore, the nondegeneracy is nonsensical and violates conservation of angular momentum of the photon.

It is absolutely physically correct and mathematically correct to solve the spin and orbital function independently since there is no a priori reason why they have to be a single eigenfunction or product of eigenfunctions. After all, they are independent physical phenomena. The two dimensional wave equation plus time is given by McQuarrie [McQuarrie, D. A., *Quantum Chemistry*, University Science Books, Mill Valley, CA, (1983), p. 207]. It is mathematically identical to the familiar rigid rotor equation of QM. The electron is confined to two dimensions ( $\theta$  and  $\phi$ ) plus time, and the corresponding wave equation solution is called an electron orbitsphere. Spherical harmonic functions and time harmonic functions are well known solutions of the angular and time components of the two dimensional wave equation plus time, respectively. The solutions appear in McQuarrie [McQuarrie, D. A., *Quantum Chemistry*, University Science Books, Mill Valley, CA, (1983), pp. 206-225]. A constant current function is also a solution of the wave equation. A constant function corresponding to the electron spin function is added to each of the spherical harmonic functions to give the charge (mass) density functions of the electron as a function of time. The integral of a spherical harmonic function over the orbitsphere is zero. The integral of the constant function over the orbitsphere is the total charge (mass) of the electron. These functions comprise the well known s, p, d, f, etc. electrons or orbitals. In the case that such an electron state arises as an excited state by photon absorption, it is radiative due to a radial dipole term in its current density function since it possesses spacetime Fourier components synchronous with waves traveling at the speed of light as shown in the Instability of the Excited States section of Ref. [1]. (See **Appendix #2** of this Response.)

Eqs. (14-15) of Ref. [58] are well known solutions of the classical wave equation in two dimensions plus time.  $Y_l^m(\theta, \phi)$  are the spherical harmonic functions with  $Y_0^0(\theta, \phi)$  the constant function. The constant charge function corresponds to the spin function with the non constant current function generated by Eqs. (10-11) and shown in Figure 2 of Ref. [58]. The solutions for  $\ell \neq 0$  corresponding to charge density waves  $Y_l^m(\theta, \phi)$  that modulate the constant spin function,  $Y_0^0(\theta, \phi)$ , are harmonic in space (spherical harmonics), and, in contrast to the spin function, rotate time harmonically at frequency  $\omega_n$  about the z-axis.

From The INTRODUCTION section of Ref. [1]:

The charge-density functions including the time-function factor are



$$\ell = 0$$

$$\rho(r, \theta, \phi, t) = \frac{e}{8\pi r^2} [\delta(r - r_n)] [Y_0^0(\theta, \phi) + Y_\ell^m(\theta, \phi)] \quad (\text{I.17})$$

$$\ell \neq 0$$

$$\rho(r, \theta, \phi, t) = \frac{e}{4\pi r^2} [\delta(r - r_n)] [Y_0^0(\theta, \phi) + \text{Re} \{Y_\ell^m(\theta, \phi) e^{i\omega_n t}\}] \quad (\text{I.18})$$

where  $\text{Re} \{Y_\ell^m(\theta, \phi) e^{i\omega_n t}\} = P_\ell^m(\cos \theta) \cos(m\phi + \omega_n t)$  and to keep the form of the spherical harmonic as a traveling wave about the z-axis,  $\omega_n = m\omega_n$ .

The spin function of the electron (see Figure 1.1 for the charge function and Figure 1.5A for the current function) corresponds to the nonradiative  $n = 1$ ,  $\ell = 0$  state of atomic hydrogen which is well known as an s state or orbital. The constant spin function is modulated by a time and spherical harmonic function as given by Eq. (I.18) and shown in Figure 1.2. The modulation or traveling charge density wave corresponds to an orbital angular momentum in addition to a spin angular momentum. These states are typically referred to as p, d, f, etc. orbitals and correspond to an  $\ell$  quantum number not equal to zero. Application of the condition from Haus [Haus, H. A., "On the radiation from point charges", American Journal of Physics, 54, (1986), pp. 1126-1129] (Eqs. (I.19-I.21)) also predicts nonradiation for a constant spin function modulated by a time and spherically harmonic orbital function. There is acceleration without radiation. (Also see Abbott and Griffiths and Goedecke [T. A. Abbott and D. J. Griffiths, Am. J. Phys., Vol. 153, No. 12, (1985), pp. 1203-1211; G. Goedecke, Phys. Rev 135B, (1964), p. 281]). Nonradiation is also shown directly via Maxwell's equations in Appendix I: Nonradiation Based on the Electromagnetic Fields and the Poynting Power Vector of Ref. [1]. However, in the case that such a state arises as an excited state by photon absorption, it is radiative due to a radial dipole term in its current density function since it possesses spacetime Fourier transform components synchronous with waves traveling at the speed of light as shown in the Instability of Excited States section of Ref. [1].

As shown in **THE ORBITSHERE EQUATION OF MOTION FOR  $\ell = 0$**  section of Ref. [1]:

In the derivation of Eqs. (1.58) and (1.59), the moment of inertia, typically caused by a point particle or a reduced mass, is  $mr^2$ . However, for  $\ell = 0$ , the electron mass and charge are uniformly distributed over the orbitsphere, a two-dimensional, spherical shell. The

orbitsphere is *not* analogous to a globe, where  $I = \frac{2}{3}mr^2$ , spinning about some axis. Each point on the sphere with mass  $m_i$  has the same angular velocity ( $\omega_n$ ), the same magnitude of linear velocity ( $v_n$ ), and the same moment of inertia ( $m_i r_n^2$ ). The motion of each point of the orbitsphere is along a great circle, and the motion of each great circle is correlated with the motion on all other great circles. The magnitude of the velocity is not a function of  $\theta$ . In contrast, the velocity of a point mass on a spinning globe is a function of  $\theta$ .

The derivation of the momenta and energies are given in Chp. 1 of Ref. [1]:

### ROTATIONAL PARAMETERS OF THE ELECTRON (ANGULAR MOMENTUM, ROTATIONAL ENERGY, AND MOMENT OF INERTIA)

One result of the correlated motion along great circles is that some of the kinetic energy is not counted in the rotational energy. That is, for any spin axis there will be an infinite number of great circles with planes passing through that axis with  $\theta$  angles other than  $90^\circ$ . All points on any one of these great circles will be moving, but not all of that motion will be part of the rotational energy; only that motion perpendicular to the spin axis will be part of the rotational energy. Thus, the rotational kinetic energy will always be less than the total kinetic energy. Furthermore, the following relationships must hold.

$$E_{\text{rotational}} = \frac{1}{2} I \omega^2 \leq \frac{1}{2} m_e v^2 \quad (1.75)$$

$$I \omega \leq \hbar \quad (1.76)$$

$$I \leq m_e r^2 \quad (1.77)$$

Furthermore, it is known from the Stern-Gerlach experiment that a beam of silver atoms splits into two components when passed through an inhomogeneous magnetic field. This experiment implies a magnetic moment of one Bohr magneton and an associated angular momentum quantum number of  $1/2$ . Historically, this quantum number is called the spin quantum number, and that designation will be retained. The angular momentum can be thought of arising from a spin component or equivalently an orbital component of the spin. The z-axis projection of the spin angular momentum was derived in the Spin Angular Momentum of the Orbitsphere with  $\ell = 0$  section.

$$L_z = I \omega \mathbf{i}_z = \pm \frac{\hbar}{2} \quad (1.78)$$

where  $\omega$  is given by Eq. (1.55); so,

$$\ell = 0$$

$$|L_z| = I \frac{\hbar}{m_e r^2} = \frac{\hbar}{2} \quad (1.79)$$

Thus,

$$I_z = I_{spin} = \frac{m_e r_n^2}{2} \quad (1.80)$$

From Eq. (1.51),

$$E_{rotational\ spin} = \frac{1}{2} [I_{spin} \omega^2] \quad (1.81)$$

From Eqs. (1.55) and (1.80),

$$E_{rotational} = E_{rotational\ spin} = \frac{1}{2} \left[ I_{spin} \left( \frac{\hbar}{m_e r_n^2} \right)^2 \right] = \frac{1}{2} \left[ \frac{m_e r_n^2}{2} \left( \frac{\hbar}{m_e r_n^2} \right)^2 \right] = \frac{1}{4} \left[ \frac{\hbar^2}{2 I_{spin}} \right] \quad (1.82)$$

When  $\ell \neq 0$ , the spherical harmonic is not a constant and the charge-density function is not uniform over the orbitsphere. Thus, the angular momentum can be thought of arising from a spin component and an orbital component.

### Derivation of the Rotational Parameters of the Electron

In the derivation of Eq. (1.59) and its solution for  $E_{rotational}$  (Eq. (1.60)), the moment of inertia,  $I$ , was assumed by McQuarrie [McQuarrie, D. A., Quantum Chemistry, University Science Books, Mill Valley, CA, (1983), pp. 206-221] to be the moment of inertia of a point particle,  $mr_n^2$ . However, the correct equation of the electron is a two dimensional shell with a constant or a constant plus a spherical harmonic angular dependence. In that case, the relationships given by Eqs. (1.75) to (1.77) must hold.

The substitution of  $NI$  for  $I$  in the rigid rotor problem [McQuarrie, D. A., Quantum Chemistry, University Science Books, Mill Valley, CA, (1983), pp. 206-221] where  $N$  is a constant does not change the form of the previous solution given by Eq. (1.60). However, the result that

$$N = \left[ \frac{\ell(\ell+1)}{\ell^2 + 2\ell + 1} \right]^{\frac{1}{2}} < 1 \quad (1.83)$$

derived below gives

$$E_{rotational} = \frac{\hbar^2 \ell(\ell+1)}{2I(\ell^2 + 2\ell + 1)} \quad (1.84)$$

and gives the moment of inertia of the orbitsphere,  $I_{orbital}$ , where  $\ell \neq 0$  as

$$NI = I_{orbital} = m_e r_n^2 \left[ \frac{\ell(\ell+1)}{(\ell^2 + 2\ell + 1)} \right]^{\frac{1}{2}} \quad (1.85)$$

The solution of Eq. (1.59) for  $|\mathbf{L}|$ , the magnitude of the orbital angular momentum, is [McQuarrie, D. A., Quantum Chemistry, University Science Books, Mill Valley, CA, (1983), pp. 206-221]

$$|\mathbf{L}| = \hbar \sqrt{\ell(\ell+1)} \quad (1.86)$$

where  $I$  of Eq. (1.59) is the moment of inertia of a point charge. It is demonstrated by Eq. (1.57) that the total sum of the magnitudes of the angular momenta of the infinitesimal points of the electron orbitsphere is  $\hbar$ ; therefore, the magnitude of the angular momentum of an electron orbitsphere must be less than  $\hbar$ , and the moment of inertia must be less than that given by  $m_e r_n^2$ . For example, the moment of inertia of the uniform spherical shell,  $I_{RS}$ , is [Fowles, G. R., Analytical Mechanics, Third Edition, Holt, Rinehart, and Winston, New York, (1977), p. 196]

$$I_{RS} = \frac{2}{3} m r_n^2 \quad (1.87)$$

Thus, Eq. (1.86) must be multiplied by a fraction,  $\frac{1}{K}$ , to give the correct angular momentum.

Given that generally  $\mathbf{L}$  is

$$\mathbf{L} = I \omega \mathbf{i}_z \quad (1.88)$$

then

$$I_{orbital} \omega \mathbf{i}_z = \hbar \frac{1}{K} \sqrt{\ell(\ell+1)}, \quad (1.89)$$

where  $\omega$  is given by Eq. (1.55). The orbital moment of inertia,  $I_{orbital}$ , is

$$I_{orbital} = m_e r_n^2 \frac{1}{K} \sqrt{\ell(\ell+1)} \quad (1.90)$$

The total kinetic energy,  $T$ , of the orbitsphere is

$$T = \frac{1}{2} m_e v_n^2 \quad (1.91)$$

Substitution of Eq. (1.56) gives

$$T = \frac{\hbar^2}{2 m_e r_n^2} \quad (1.92)$$

$E_{rotational}$  of the rigid shell is given by Eq. (1.51) with  $I$  given by Eq. (1.87).  $E_{rotational\ orbital}$  of the orbitsphere is given by Eq. (1.60) multiplied by the fraction  $\frac{1}{K^2}$  so that Eqs. (1.75) to (1.77) hold with  $I = m_e r_n^2$ .

$$E_{rotational\ orbital} = \frac{\hbar^2}{2I} \left[ \frac{\ell(\ell+1)}{K^2} \right] \quad (1.93)$$

Eq. (1.59) can be expressed in terms of the variable  $x$  which is substituted for  $\cos \theta$ . The resulting function  $P(x)$  is called Legendre's equation and is a well-known equation in classical physics. It occurs in a variety of problems that are formulated in spherical coordinates. When the power series method of solution is applied to  $P(x)$ , the series must be truncated in order that the solutions be finite at  $x = \pm 1$ . The solution to Legendre's equation given by Eq. (1.60) is the maximum term of a series of solutions corresponding to the  $m$  and  $\ell$  values [McQuarrie, D. A., Quantum Chemistry, University Science Books, Mill Valley, CA, (1983), pp. 206-221, Pauling, Linus, Wilson, E., Bright, Introduction to Quantum

Mechanics with Applications to Chemistry, McGraw-Hill Book Company, New York, (1935), pp. 118-121]. The rotational energy must be normalized by the total number of states-each corresponding to a set of quantum numbers of the power series solution. As demonstrated in the Excited States of the One Electron Atom (Quantization) section, the quantum numbers of the excited states are

$$\begin{aligned} n &= 2, 3, 4, \dots \\ \ell &= 1, 2, \dots, n-1 \\ m &= -\ell, -\ell+1, \dots, 0, \dots, +\ell \end{aligned}$$

In the case of an orbitsphere excited state, each rotational state solution of Eq. (1.59) (Legendre's equation) corresponds to a multipole moment of the charge-density function (Eq. (1.65)).  $E_{\text{rotational orbital}}$  is normalized by  $N$ , the total number of multipole moments.  $N$ , the total number of multipole moments where each corresponds to an  $\ell$  and  $m_\ell$  quantum number of an energy level corresponding to a principal quantum number of  $n$  is

$$N = \sum_{\ell=0}^{n-1} \sum_{m_\ell=-\ell}^{+\ell} 1 = \sum_{\ell=0}^{n-1} 2\ell + 1 = n^2 = (\ell + 1)^2 = \ell^2 + 2\ell + 1 \quad (1.94)$$

Thus,  $K^2$  is equal to  $N$  given by Eq. (1.94). Substitution of Eq. (1.94) into Eq. (1.93) gives

$$E_{\text{rotational orbital}} = \frac{\hbar^2}{2I} \left[ \frac{\ell(\ell+1)}{\ell^2 + 2\ell + 1} \right] = \frac{\hbar^2}{2I} \left[ \frac{\ell}{\ell+1} \right] \quad (1.95)$$

Substitution of Eq. (1.94) into Eq. (1.90) gives the orbital moment of inertia.

$$I_{\text{orbital}} = m_e r_n^2 \left[ \frac{\ell(\ell+1)}{\ell^2 + 2\ell + 1} \right]^{\frac{1}{2}} = m_e r_n^2 \sqrt{\frac{\ell}{\ell+1}} \quad (1.96)$$

In the case of the excited states, the orbitsphere charge-density function for  $\ell \neq 0$ , Eq. (1.65), is the sum of two functions of equal magnitude.  $L_z$ , total is given by the sum of the spin and orbital angular momenta. The principal energy levels of the excited states are split when a magnetic field is applied. The energy shifts due to spin and orbital angular momenta are given in the Spin and Orbital Splitting section.

$\ell \neq 0$

$$L_{z \text{ total}} = L_{z \text{ spin}} + L_{z \text{ orbital}} \quad (1.97)$$

Similarly, the orbital rotational energy arises from a spin function (spin angular momentum) modulated by a spherical harmonic angular function (orbital angular momentum). The time-averaged orbital rotational energy is zero; the magnitude is given by Eq. (1.95); the rotational energy due to spin is given by Eq. (1.82); the total kinetic energy is given by Eq. (1.92).

$$\langle E_{\text{rotational orbital}} \rangle = 0 \quad (1.98)$$

The demonstration that the modulated orbitsphere solutions are solutions of the wave equation appears in Box 1.1.

Applicant's angular functions are solutions of the wave equation as shown in BOX 1.1. DERIVATION OF THE ROTATIONAL PARAMETERS OF THE ELECTRON FROM A SPECIAL CASE OF THE WAVE EQUATION—THE RIGID ROTOR EQUATION of Ref. [1].

Applicant's physical solutions eliminate the fatal flaws of QM. Spin is given; whereas, the SE fail to give spin. Applicant's solutions are further stable with respect to radiation as shown in Appendix I of Ref. [1] and in Ref. [58]; whereas, those of QM are not as discussed previously<sup>137</sup>. The test of a theory is that it agrees with physics, not mathematical postulates.

Applicant's response to Examiner's Ref. [11] posted to the same hydrino study group in Sept. (2001) is attached. The cited author P. Zimmerman has publicly stated his intention to "stab a knife into the heart of CQM" which is improper behavior for a scientist. Furthermore, his competence is questionable given his many outlandish statements and positions posted to this group such as "conservation of energy as a formal concept is quite modern" [P. Zimmerman post of 5/21/03], and his clear lack of understanding for the basic concepts of Maxwell's equations as summarized in R. Mills post on 5/23/03. The Examiner shows bias and poor judgment in citing material posted to an internet chat group from an arch cynic with a significant vested interest that he is openly protecting. The material is not peer reviewed which sets a double standard by requiring that Applicant's work be peer-reviewed.

#### **6. Response to argument that "Applicant misunderstands the Uncertainty Principle in QM"**

It would be fair to Applicant if the PTO assigned an Examiner skilled in Maxwell's equations to this case rather than one biased by QM. The Examiner's condescending statement about the HUP reveals his bias as a QM aficionado due to a significant conflict of interest—specifically defending a paradigm in which the Examiner has based his entire career and livelihood. Professors have taught many outdated concepts and theories that were eventually replaced. Theories advance over time, and the truth is that no one understands QM or the HUP as discussed by Laloë [F. Laloë, Do we really understand quantum mechanics? Strange correlations, paradoxes, and theorems, Am. J. Phys. 69 (6), June 2001, 655-701]. It makes no sense since it depends on  $\Psi$  which can not be based in reality as discussed in Ref. [17] and the references therein as well as others<sup>138</sup>.

The Examiner is confused about mathematics versus physics. The spherical harmonic functions significantly predate QM. The existence of spherical harmonic functions is not limited to or the equivalent of SE probability-waves. A spherical harmonic distribution of charge that moves as a wave, time harmonically on a spherical surface is a real physical problem that is

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<sup>137</sup> Reference Nos. Chp. 35 of Ref. 1, 5, 17, 21, 22, 53, 58, 80, 94

<sup>138</sup> Reference Nos. 1, 5, 53, 58, 80, 94

distinct from the purely mathematical probability-waves envisioned by the Examiner. Applicant correctly applies solutions of the Laplacian, the wave equation, and Maxwell's equations.

The Examiner's strained argument to avoid a situation wherein  $\delta\theta \rightarrow \infty$  further shows the internal inconsistency of QM. An excited state has a single angular momentum and orbital splitting energy for a given  $\ell$  quantum number, not multiple as required by QM in order not to violate the HUP.

The Examiner's requirement of taking linear combinations of eigenfunctions to result in a "wavefunction" solution is internally inconsistent with Examiner's point of # 5(repeated) wherein the Examiner claims the SE spherical harmonic solutions can not be linear combinations since the Kroenecker delta is not obtained as required since the probability-density functions must be squared.

The Examiner's use of the HUP further demonstrates that its use in QM is totally internally inconsistent as shown by Feynman's failed attempt to use it to provide a QM basis for the stability of the hydrogen atom as discussed in Ref. [80]. Other failures of the HUP are discussed in Ref. [80]. For example, it is taught that the HUP is the basis of the wave-particle duality, but that has been proven wrong the an experiment by Durr et. al. [S. Durr, T. Nonn, G. Rempe, Nature, September 3, (1998), Vol. 395, pp. 33-37] as discussed previously<sup>139</sup>. It predicts perpetual motion as discussed in [P. F. Schewe and B. Stein, Physic News Update, The American Institute of Physics Bulletin of Physics News, Number 494, July 17, (2000), A. Allahverdyan and T. Nieuwenhuizen, Phys. Rev. Lett., Vol. 85, No. 9, August 28, (2000), pp. 1799-1802] and Ref. [17]. It predicts zero point energy of the vacuum which gives rise to the inescapable prediction of an essentially infinite cosmological constant as discussed previously in Appendix II of Ref. [1] and also Ref. [17]. It also predicts zero point vibration which is not experimentally observed as discussed in Ref. [94]. Other data with far-fetched interpretations based on the HUP such the existence of the same  ${}^9\text{Be}^+$  ion in two places at once, supercurrents flowing in opposite directions at once, and spooky actions at a distance are also explained by first principle laws which demonstrate that the HUP is not a physical principle as discussed in the Foreword section and Chp 37 of Ref. [1] as well as Ref. [80]. Rather it is a misinterpretation of applying the Schwartz Inequality to the wavefunction interpreted as a probability wave [McQuarrie, D. A., *Quantum Chemistry*, University Science Books, Mill Valley, CA, (1983), pp. 135-140]. The mathematical result shows that the electron can have a continuum of momenta and positions in the  $n=1$  state with a continuum of energies simultaneously which can not be physical. This result is independent of error introduced by measurement.

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<sup>139</sup> Reference Nos. 17, 80, 94

## 7. Response to argument that "Applicant's concept of electron spin is incorrect"

As discussed in #5 of this Response, the electron is an extended particle, not a point as confused by the Examiner. QM has to rely on a postulated solution since spin (current) in one dimension is nonphysical and nonsensical. CQM solves spin and orbital angular momenta and energies physically. The charge and current density function are solved from Maxwell's equations, not the SE or the Dirac equation. The for p, d, f, etc. orbitals, the spherical harmonic angular functions are charge-density waves on the surface of a spherical shell that modulate the constant, uniform-charged spin function. The time-average rotational energy of the former is zero as given by Eq. (1.98) of Ref. [1]. The rotational energy of the spin function is given by Eq. (1.82) of Ref. [1].

Applicant's solution for spin is correct in that it agrees, to the limit of experimental observation, with all of the parameters measured on spin and it consistent with all physical laws including Maxwell's equations and special relativity. Applicant does not follow the approach of QM postulates and associated probability waves using an improper wave equation. The SE equation misses spin entirely and the Dirac equation gives rise to many problems as discussed previously<sup>140</sup>, and also by others such as Weisskopf [V. F. Weisskopf, Reviews of Modern Physics, Vol. 21, No. 2, (1949), pp. 305-315] discussed in #1 of this Response. The Examiner confuses the mathematical postulates of QM with Applicant's physical solution.

The electron has a measured magnetic field and corresponding magnetic moment of a Bohr magneton. The field requires a unique current according to Maxwell's equations. The solution is derived from Maxwell's equation in Ref. [58] and Chp 1 of Ref. [1], where several boundary conditions must be and are satisfied. In the case of the spin function, there is no rotation about an axis. Rather the current corresponding to spin is generated by a basis set of two orthogonal great circles current loops according to Eqs. (10-11) and is shown in Figure 2 of Ref. [58]. In this case, the velocity is the same for each point. More explicitly, the orbitsphere comprises a two-dimensional spherical shell of moving charge. The corresponding current pattern of the orbitsphere comprises an infinite series of correlated orthogonal great circle current loops. The current pattern (shown in Figure 2 of Ref. [58]) is generated over the surface by two orthogonal sets of an infinite series of nested rotations of two orthogonal great circle current loops where the coordinate axes rotate with the two orthogonal great circles. Each infinitesimal rotation of the infinite series is about the new x-axis and new y-axis which results from the preceding such rotation. For each of the two sets of nested rotations, the angular sum of the rotations about each rotating x-axis and y-axis totals  $\sqrt{2}\pi$  radians. The current pattern gives rise to the phenomenon corresponding to the spin quantum number.

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<sup>140</sup> Reference Nos. 1, 5, 17, 21, 22, 53, 58, 80, 94



From Chp. 1 of Ref. [1]:

The Stern Gerlach experiment demonstrates that the magnetic moment of the electron can only be parallel or antiparallel to an applied magnetic field. In spherical coordinates, this implies a spin quantum number of  $1/2$  corresponding to an angular momentum on the z-axis of  $\frac{\hbar}{2}$ .

However, the Zeeman splitting energy corresponds to a magnetic moment of  $\mu_B$  and implies an electron angular momentum on the z-axis of  $\hbar$ —twice that given by Eq. (1.68-1.71) of Ref. [1].

The orbitsphere with  $\ell = 0$  is a shell of negative charge current comprising correlated charge motion along great circles. The superposition of the vector projection of the orbitsphere angular momentum on the z-axis is  $\frac{\hbar}{2}$  with an orthogonal component of  $\frac{\hbar}{4}$ . As shown in the Orbitsphere Equation of Motion for  $\ell = 0$  section of Ref. [1], the application of a magnetic field to the orbitsphere gives rise to a precessing angular momentum vector  $\mathbf{S}$  directed from the origin of the orbitsphere at an angle of  $\theta = \frac{\pi}{3}$  relative to the applied magnetic field. The precession of  $\mathbf{S}$  with an angular momentum of  $\hbar$  forms a cone in the nonrotating laboratory frame to give a perpendicular projection of  $\mathbf{S}_\perp = \pm\sqrt{\frac{3}{4}}\hbar$  (Eq. (1.74a) of Ref. [1]) and a projection onto the axis of the applied magnetic field of  $\mathbf{S}_\parallel = \pm\frac{\hbar}{2}$  (Eq. (1.74b) of Ref. [1]). The superposition of the  $\frac{\hbar}{2}$  z-axis component of the orbitsphere angular momentum and the  $\frac{\hbar}{2}$  z-axis component of  $\mathbf{S}$  gives  $\hbar$  corresponding to the observed magnetostatic electron magnetic moment of a Bohr magneton.

In summary:

## STERN-GERLACH EXPERIMENT

The Stern-Gerlach experiment implies a magnetic moment of one Bohr magneton and an associated angular momentum quantum number of  $1/2$  ( $s = \frac{1}{2}$ ;  $m_s = \pm\frac{1}{2}$ ). The superposition of the vector projection of the orbitsphere angular momentum on the z-axis is  $\frac{\hbar}{2}$  with an orthogonal component of  $\frac{\hbar}{4}$ . Excitation of a resonant Larmor precession gives rise to  $\hbar$  on an axis  $\mathbf{S}$  that precesses about the z-axis called the spin axis at the Larmor frequency at an angle of  $\theta = \frac{\pi}{3}$  to give a perpendicular projection of

$$\mathbf{S}_\perp = \hbar \sin \frac{\pi}{3} = \pm\sqrt{\frac{3}{4}}\hbar \mathbf{i}_{y_k}$$

and a projection onto the axis of the applied magnetic field of

$$S_{\parallel} = \pm \hbar \cos \frac{\pi}{3} = \pm \frac{\hbar}{2} \mathbf{i}_{z_R}$$

The superposition of the  $\frac{\hbar}{2}$  z-axis component of the orbitsphere angular momentum and the  $\frac{\hbar}{2}$  z-axis component of S gives  $\hbar$  corresponding to the observed electron magnetic moment of a Bohr magneton,  $\mu_B$ .

The observed electron parameters are explained physically. Classical laws give 1.) a gyromagnetic ratio of  $\frac{e}{2m}$ , 2.) a Larmor precession frequency of  $\frac{e\mathbf{B}}{2m}$ , 3.) the Stern-Gerlach experimental result of quantization of the angular momentum that implies a spin quantum number of 1/2 corresponding to an angular momentum of  $\frac{\hbar}{2}$  on the z-axis, and 4.) the observed Zeeman splitting due to a magnetic moment of a Bohr magneton  $\mu_B = \frac{e\hbar}{2m_e}$  corresponding to an angular momentum of  $\hbar$  on the z-axis. Furthermore, the solution is relativistically invariant as shown in the Special Relativistic Correction to the Ionization Energies section. Dirac originally attempted to solve the bound electron physically with stability with respect to radiation according to Maxwell's equations with the further constraints that it was relativistically invariant and gave rise to electron spin [P. Pearle, Foundations of Physics, "Absence of radiationless motions of relativistically rigid classical electron", Vol. 7, Nos. 11/12, (1977), pp. 931-945]. He was unsuccessful and resorted to the current mathematical probability-wave model that has many problems as discussed in Appendix II: Quantum Electrodynamics (QED) is Purely Mathematical and Has No Basis in Reality of Ref. [1].

The g factor is predicted in the g Factor section of Ref. [1]. It is given in a closed form equation (Eq. (1.192)) that contains the fine structure constant only. The calculated  $g/2=1.001\,159\,652\,137$  (Eq. (1.204) of Ref. [1]). The experimental  $g/2=1.001\,159\,652\,188$  (Eq. (1.205) of Ref. [1]).

The *postulated* QED theory of  $\frac{g}{2}$  is based on the determination of the terms of a *postulated* power series in  $\alpha/\pi$  where each *postulated* virtual particle is a source of *postulated* vacuum polarization that gives rise to a *postulated* term. The algorithm involves scores of *postulated* Feynman diagrams corresponding to thousands of matrices with thousands of integrations per matrix requiring decades to reach a consensus on the "appropriate" *postulated* algorithm to remove the intrinsic infinities. The remarkable agreement between Eqs. (1.204) and

(1.205) demonstrates that  $\frac{g}{2}$  may be derived in closed form from Maxwell's equations in a simple straightforward manner that yields a result with eleven figure agreement with experiment—the limit of the experimental capability of the measurement of the fundamental constants that determine  $\alpha$ . In Appendix II: Quantum Electrodynamics is Purely Mathematical and Has No Basis in Reality of Ref. [1], the Maxwellian result is contrasted with the QED algorithm of invoking virtual particles, zero point fluctuations of the vacuum, and negative energy states of the vacuum. Rather than an infinity of radically different QED models, an essential feature is that *Maxwellian solutions are unique*.

Ironically, Dirac originally attempted to solve the bound electron physically with stability with respect to radiation according to Maxwell's equations with the further constraints that it was relativistically invariant and gave rise to electron spin [P. Pearle, Foundations of Physics, "Absence of radiationless motions of relativistically rigid classical electron", Vol. 7, Nos. 11/12, (1977), pp. 931-945.]. He was unsuccessful and resorted to the current mathematical-probability-wave model that has many problems as discussed in Appendix II: Quantum Electrodynamics (QED) is Purely Mathematical and Has No Basis in Reality of Ref. [1]. From Weisskopf [V. F. Weisskopf, Reviews of Modern Physics, Vol. 21, No. 2, (1949), pp. 305-315], "Dirac's quantum electrodynamics gave a more consistent derivation of the results of the correspondence principle, but it also brought about a number of new and serious difficulties." Quantum electrodynamics; 1.) does not explain nonradiation of bound electrons; 2.) contains an internal inconsistency with special relativity regarding the classical electron radius—the electron mass corresponding to its electric energy is infinite; 3.) it admits solutions of negative rest mass and negative kinetic energy; 4.) the interaction of the electron with the predicted zero-point field fluctuations leads to infinite kinetic energy and infinite electron mass; 5.) Dirac used the unacceptable states of negative mass for the description of the vacuum; yet, infinities still arise.

Dirac's postulated relativistic wave equation also leads to the inescapable results that it gives rise to the Klein Paradox and a cosmological constant that is at least 120 orders of magnitude larger than the best observational limit as discussed in Chp. 1, Appendix II of Ref. [1] and previously<sup>141</sup>.

#### **8. Response to argument that "Applicant's hydrogen wave function is seriously flawed"**

The Examiner again incorrectly analyzes Applicant's theory from the perspective of QM. Applicant's theory is not based on the SE or Dirac equation. Applicant does not follow the approach of QM postulates and associated probability waves using an improper wave equation.

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<sup>141</sup> Reference Nos. 5, 17, 21, 33, 53, 58, 80, 94

QM gives no basis for the stability of the  $n=1$  state and the instability of excited states as discussed previously<sup>142</sup>. It does not obey Maxwell's equations. In contrast, in Chp. 2 of Ref. [1], CQM gives closed form solutions for the resonant photons and excited state electron functions. The free space photon also comprises a radial Dirac delta function, and the angular momentum of the photon given by  $\mathbf{m} = \frac{1}{8\pi} \text{Re}[\mathbf{r} \times (\mathbf{E} \times \mathbf{B}^*)] = \hbar$  in the Photon section is conserved for the solutions for the resonant photons and excited state electron functions. It can be demonstrated that the resonance condition between these frequencies is to be satisfied in order to have a net change of the energy field [Mizushima, M., Quantum Mechanics of Atomic Spectra and Atomic Structure, W.A. Benjamin, Inc., New York, (1970), p.17]. In the present case, the correspondence principle holds. That is the change in angular frequency of the electron is equal to the angular frequency of the resonant photon that excites the resonator cavity mode corresponding to the transition, and the energy is given by Planck's equation. The predicted energies, Lamb shift, fine structure splitting, hyperfine structure, resonant line shape, line width, selection rules, etc. are in agreement with observation.

Of course transitions with  $\Delta n \neq 0$  are allowed based on Eq. (2.42) of Ref. [1] where excited states are radiative according to Maxwell's equations as given in the Instability of Excited States section of Ref. [1] and the transition probabilities are given by Eq. (2.44) of Ref. [1] which depends on the radius. Furthermore, it is well known that the Stark effect is solved classically.

#### 9. Response to argument that "Applicant's application of Special Relativity theory is incorrect"

It was shown in the Special Relativistic Correction to the Ionization Energies section of Ref. [1] that the electron's motion is tangential to the radius; thus, the electron radius is Lorentzian invariant. That is, for the case that  $k$  is the lightlike  $k^0$ , with  $k = \omega_n / c$ ,  $r_n$  is invariant. It was also shown that this condition determines that the electron's angular momentum of  $\hbar$ ,  $\frac{e}{m_e}$  of Eq. (1.99) of Ref. [1], and the electron's magnetic moment of a Bohr magneton  $\mu_B$  are invariant. In the lab frame, the effect of the relativistic length contraction and time dilation for constant spherical motion is a change in the angle of motion with a corresponding decrease in the electron wavelength. The angular motion becomes projected onto the radial axis which contracts, and the extent of the decrease in the electron wavelength and radius due to the electron motion in the laboratory inertial frame are given by

$$\lambda = 2\pi r' \sqrt{1 - \left(\frac{v}{c}\right)^2} \sin \left[ \frac{\pi}{2} \left( 1 - \left(\frac{v}{c}\right)^2 \right)^{3/2} \right] + r' \cos \left[ \frac{\pi}{2} \left( 1 - \left(\frac{v}{c}\right)^2 \right)^{3/2} \right] \quad (1.248)$$

<sup>142</sup> Reference Nos. 1, 80

and

$$r = r' \left[ \sqrt{1 - \left(\frac{v}{c}\right)^2} \sin \left[ \frac{\pi}{2} \left(1 - \left(\frac{v}{c}\right)^2\right)^{3/2} \right] + \frac{1}{2\pi} \cos \left[ \frac{\pi}{2} \left(1 - \left(\frac{v}{c}\right)^2\right)^{3/2} \right] \right] \quad (1.249)$$

respectively. Then, the relativist factor  $\gamma^*$  is

$$\gamma^* = \frac{2\pi}{2\pi \sqrt{1 - \left(\frac{v}{c}\right)^2} \sin \left[ \frac{\pi}{2} \left(1 - \left(\frac{v}{c}\right)^2\right)^{3/2} \right] + \cos \left[ \frac{\pi}{2} \left(1 - \left(\frac{v}{c}\right)^2\right)^{3/2} \right]} \quad (1.250)$$

where the velocity is given by Eq. (1.56) of Ref. [1] with the radius given by Eq. (1.223) [1].

Plots of ratio of the radii from Eq. (1.249) of Ref. [1] and the correction to the ionization energy  $\gamma^*$  (Eq. (1.250) of Ref. [1]) as a function of the electron velocity  $v$  relative to the speed of light  $c$  are given in Figures 1.13 and 1.14, respectively.

Figure 1.13. The normalized radius as a function of  $v/c$  due to relativistic contraction.

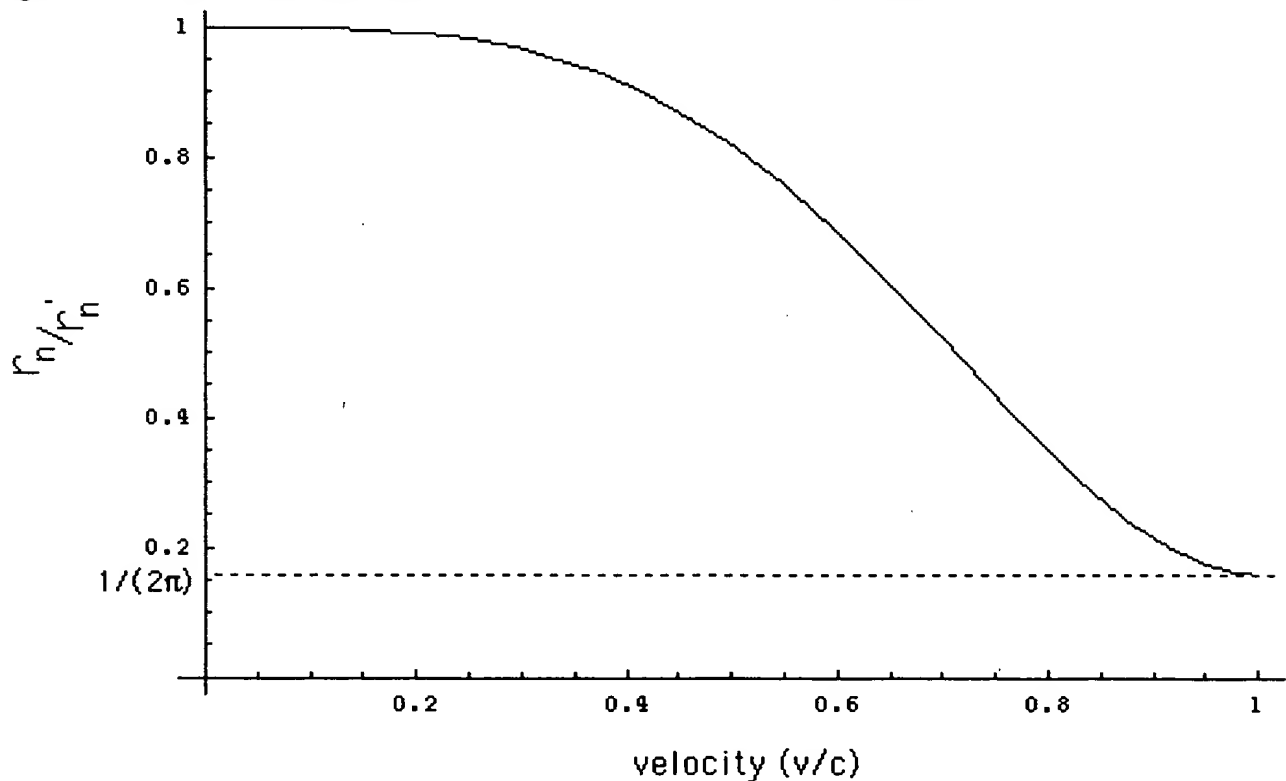
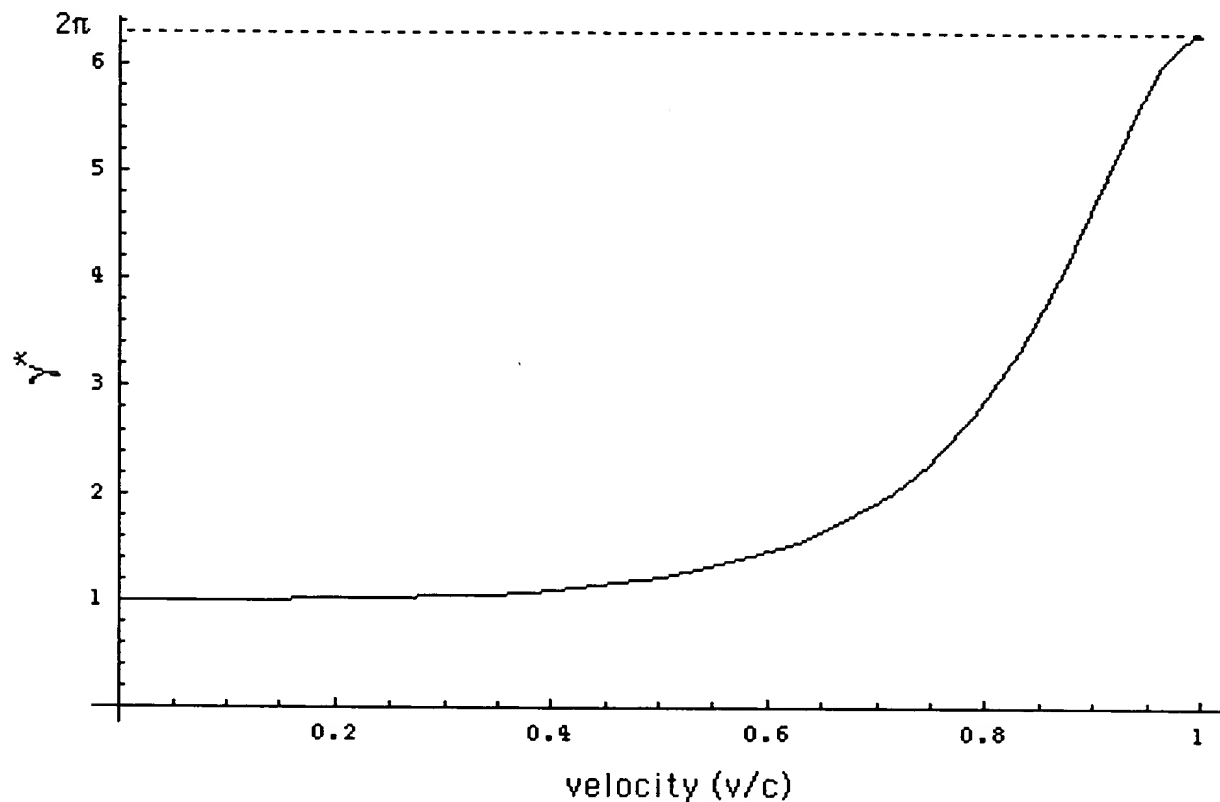


Figure 1.14. The relativistic correction to the one-atom-electron ionization energies as a function of  $v/c$  due to relativistic contraction.



The relativistically corrected one electron ionization energies given by the product of Eqs. (1.233) and (1.250) is

$$E_{ele} = -\gamma \cdot \frac{Z^2 e^2}{8\pi\epsilon_0 a_0} \frac{\mu}{m_e} = -\gamma \cdot \frac{\mu}{m_e} Z^2 \times 2.1799 \times 10^{-18} \text{ J} = -\gamma \cdot \frac{\mu}{m_e} Z^2 \times 13.606 \text{ eV} \quad (1.251)$$

where the reduced mass term  $\mu_e$  corresponds to the electron-nucleus relativistic correction and is only given by Eq. (1.224) for the hydrogen atom where  $Z = 1$ . These energies are plotted in Figure 1.15 and are given in Table 1.4.

Figure 1.15. The relativistically corrected one-electron-atom ionization energies as a function of the nuclear charge  $Z$ .

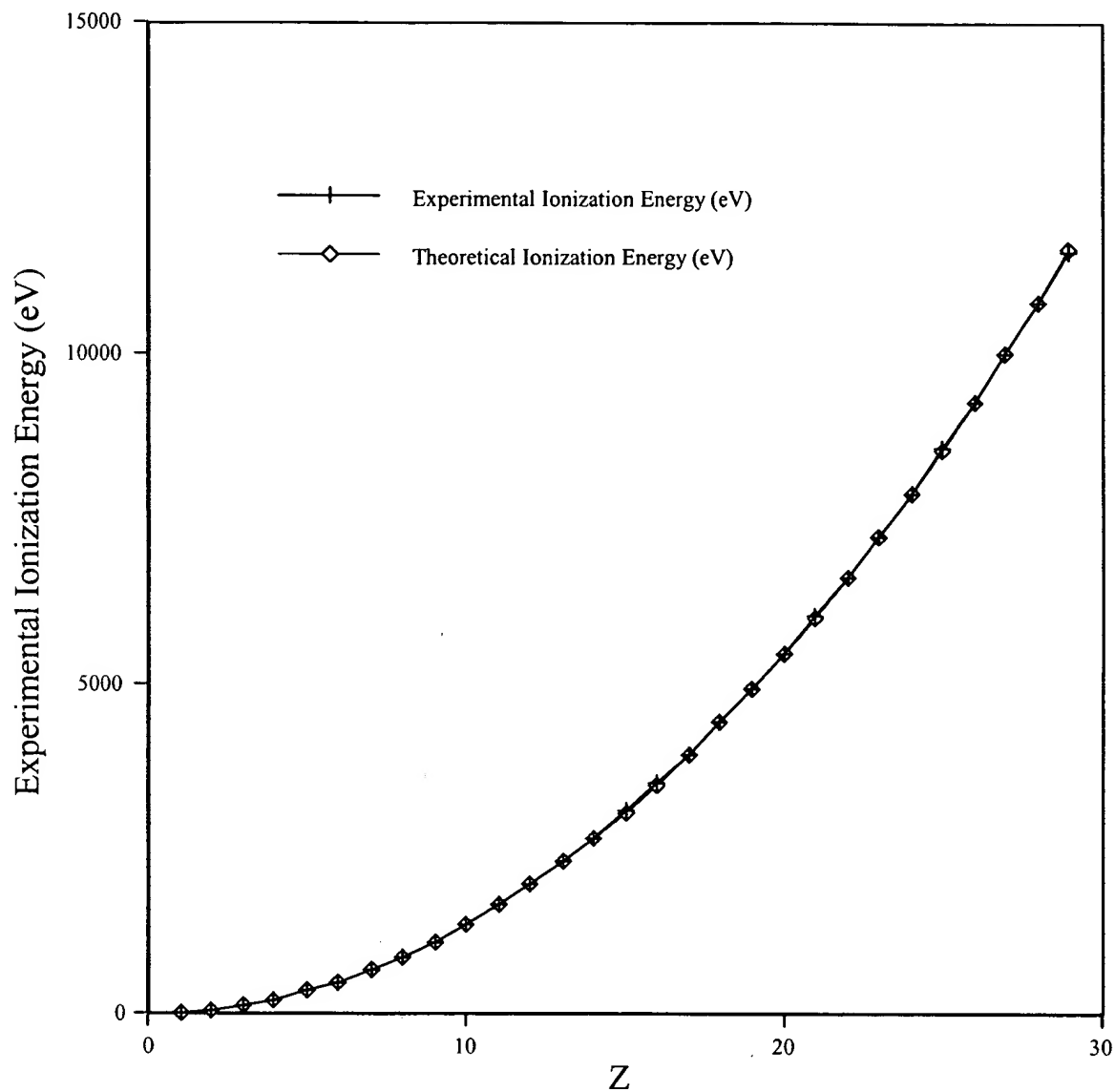


Table 1.4. Relativistically corrected ionization energies for some one-electron atoms.

One e Atom	Z	$\gamma^*$ Eq. (1.250)	Theoretical Ionization Energies (eV) Eq. (1.251)	Experimental Ionization Energies <sup>a</sup> (eV)	Relative Difference between Experimental and Calculated
H	1	1.000007	13.59849	13.59844	0.00000
He <sup>+</sup>	2	1.000027	54.40986	54.41778	0.00015
Li <sup>2+</sup>	3	1.000061	122.43743	122.45429	0.00014
Be <sup>3+</sup>	4	1.000109	217.68689	217.71865	0.00015
B <sup>4+</sup>	5	1.000172	340.16647	340.2258	0.00017
C <sup>5+</sup>	6	1.000251	489.88727	489.99334	0.00022
N <sup>6+</sup>	7	1.000347	666.86361	667.046	0.00027
O <sup>7+</sup>	8	1.000461	871.11351	871.4101	0.00034
F <sup>8+</sup>	9	1.000595	1102.65919	1103.1176	0.00042
Ne <sup>9+</sup>	10	1.000751	1361.52774	1362.1995	0.00049
Na <sup>10+</sup>	11	1.000930	1647.75175	1648.702	0.00058
Mg <sup>11+</sup>	12	1.001135	1961.37017	1962.665	0.00066
Al <sup>12+</sup>	13	1.001368	2302.42910	2304.141	0.00074
Si <sup>13+</sup>	14	1.001631	2670.98273	2673.182	0.00082
P <sup>14+</sup>	15	1.001927	3067.09439	3069.842	0.00090
S <sup>15+</sup>	16	1.002260	3490.83760	3494.1892	0.00096
Cl <sup>16+</sup>	17	1.002631	3942.29722	3946.296	0.00101
Ar <sup>17+</sup>	18	1.003045	4421.57073	4426.2296	0.00105
K <sup>18+</sup>	19	1.003505	4928.76949	4934.046	0.00107
Ca <sup>19+</sup>	20	1.004014	5464.02015	5469.864	0.00107
Sc <sup>20+</sup>	21	1.004577	6027.46611	6033.712	0.00104
Ti <sup>21+</sup>	22	1.005197	6619.26901	6625.82	0.00099
V <sup>22+</sup>	23	1.005879	7239.61041	7246.12	0.00090
Cr <sup>23+</sup>	24	1.006626	7888.69338	7894.81	0.00078
Mn <sup>24+</sup>	25	1.007444	8566.74431	8571.94	0.00061
Fe <sup>25+</sup>	26	1.008338	9274.01477	9277.69	0.00040
Co <sup>26+</sup>	27	1.009311	10010.78335	10012.12	0.00013
Ni <sup>27+</sup>	28	1.010370	10777.35772	10775.4	-0.00018
Cu <sup>28+</sup>	29	1.011520	11574.07668	11567.617	-0.00056

<sup>a</sup> From theoretical calculations, interpolation of H isoelectronic and Rydberg series, and experimental data [C. E. Moore, "Ionization Potentials and Ionization Limits Derived from the Analyses of Optical Spectra, Nat. Stand. Ref. Data Ser.-Nat. Bur. Stand. (U.S.), No. 34, 1970; David R. Linde, *CRC Handbook of Chemistry and Physics*, 79 th Edition, CRC Press, Boca Raton, Florida, (1998-9), p. 10-175 to p. 10-177].

The agreement between the experimental and calculated values of Table 1.4 is well within the experimental capability of the spectroscopic determinations including the values at large Z which relies on X-ray spectroscopy. In this case, the experimental capability is three to



four significant figures which is consistent with the last column. The hydrogen atom isoelectronic series is given in Table 1.4 [C. E. Moore, "Ionization Potentials and Ionization Limits Derived from the Analyses of Optical Spectra, Nat. Stand. Ref. Data Ser.-Nat. Bur. Stand. (U.S.), No. 34, 1970; David R. Linde, *CRC Handbook of Chemistry and Physics*, 79 th Edition, CRC Press, Boca Raton, Florida, (1998-9), p. 10-175 to p. 10-177] to much higher precision than the capability of X-ray spectroscopy, but these values are based on theoretical and interpolation techniques rather than data alone. Ionization energies are difficult to determine since the cut-off of the Rydberg series of lines at the ionization energy is often not observed, and the ionization energy must be determined from theoretical calculations, interpolation of H isoelectronic and Rydberg series, as well as direct experimental data.

Similarly, the relativistic ionization energies for two and three electron atoms are given in the Two-Electron Atom and Three-Electron Atom sections of Ref. [1], respectively. It is impossible to use QM to solve such problems in closed equations derived from first principles that contain fundamental constants only.

Applicant's theory is further demonstrated to be in agreement with special relativity based on the success of the predictions for the electron g factor and the fine structure of the hydrogen atom summarized *infra*.

## ELECTRON g FACTOR

From Chp. 1 of Ref. [1]:

In contrast to the QM and QED cases (See Appendix II: Quantum Electrodynamics is Purely Mathematical and Has No Basis in Reality), the fourth quantum number arises naturally in CQM as derived in the Electron g Factor section. The Stern-Gerlach experiment implies a magnetic moment of one Bohr magneton and an associated angular momentum quantum number of 1/2. Historically, this quantum number is called the spin quantum number, s

( $s = \frac{1}{2}$ ;  $m_s = \pm \frac{1}{2}$ ). Conservation of angular momentum of the orbitsphere permits a discrete

change of its "kinetic angular momentum" ( $\mathbf{r} \times m\mathbf{v}$ ) with respect to the field of  $\frac{\hbar}{2}$ , and

concomitantly the "potential angular momentum" ( $\mathbf{r} \times e\mathbf{A}$ ) must change by  $-\frac{\hbar}{2}$ . The flux

change,  $\phi$ , of the orbitsphere for  $r < r_n$  is determined as follows:

$$\Delta \mathbf{L} = \frac{\hbar}{2} - \mathbf{r} \times e\mathbf{A} \quad (\text{I.9})$$

$$= \left[ \frac{\hbar}{2} - \frac{e2\pi r A}{2\pi} \right] \hat{z} \quad (\text{I.10})$$

$$= \left[ \frac{\hbar}{2} - \frac{e\phi}{2\pi} \right] \hat{z} \quad (I.11)$$

In order that the change of angular momentum,  $\Delta L$ , equals zero,  $\phi$  must be  $\Phi_0 = \frac{h}{2e}$ , the magnetic flux quantum. Thus, to conserve angular momentum in the presence of an applied magnetic field, the orbitsphere magnetic moment can be parallel or antiparallel to an applied field as observed with the Stern-Gerlach experiment, and the flip between orientations is accompanied by the "capture" of the magnetic flux quantum by the orbitsphere. During the spin-flip transition, power must be conserved. Power flow is governed by the Poynting power theorem,

$$\nabla \cdot (\mathbf{E} \times \mathbf{H}) = -\frac{\partial}{\partial t} \left[ \frac{1}{2} \mu_0 \mathbf{H} \cdot \mathbf{H} \right] - \frac{\partial}{\partial t} \left[ \frac{1}{2} \epsilon_0 \mathbf{E} \cdot \mathbf{E} \right] - \mathbf{J} \cdot \mathbf{E} \quad (I.12)$$

Eq. (I.13) derived in the Electron g Factor section gives the total energy of the flip transition which is the sum of the energy of reorientation of the magnetic moment (1st term), the magnetic energy (2nd term), the electric energy (3rd term), and the dissipated energy of a fluxon treading the orbitsphere (4th term), respectively.

$$\Delta E_{mag}^{spin} = 2 \left( 1 + \frac{\alpha}{2\pi} + \frac{2}{3} \alpha^2 \left( \frac{\alpha}{2\pi} \right) - \frac{4}{3} \left( \frac{\alpha}{2\pi} \right)^2 \right) \mu_B B \quad (I.13)$$

$$\Delta E_{mag}^{spin} = g \mu_B B \quad (I.14)$$

The spin-flip transition can be considered as involving a magnetic moment of  $g$  times that of a Bohr magneton. The  $g$  factor is redesignated the fluxon  $g$  factor as opposed to the anomalous  $g$  factor. The calculated value of  $\frac{g}{2}$  is

$$1.001\,159\,652\,137$$

The experimental value [R. S. Van Dyck, Jr., P. Schwinberg, H. Dehmelt, "New high precision comparison of electron and positron  $g$  factors", Phys. Rev. Lett., Vol. 21, (1987), p. 26-29] of  $\frac{g}{2}$  is

$$1.001\,159\,652\,188(4).$$

## SPIN-ORBITAL COUPLING

Due to 1.) the invariance of each of  $\frac{e}{m_e}$  of the electron, the electron angular momentum of  $\hbar$ , and  $\mu_B$  from the spin angular and orbital angular momentum, 2.) the condition that flux

must be linked by the electron orbitsphere in units of the magnetic flux quantum, and 3.) the maximum projection of the spin angular momentum of the electron onto an axis is  $\sqrt{\frac{3}{4}}\hbar$ , the magnetic energy term of the electron g-factor gives the spin-orbital coupling energy  $E_{s/o}$ :

$$E_{s/o} = 2 \frac{\alpha}{2\pi} \left( \frac{e\hbar}{2m_e} \right) \frac{\mu_0 e \hbar}{2(2\pi m_e) \left( \frac{r}{2\pi} \right)^3} \sqrt{\frac{3}{4}} = \frac{\alpha \pi \mu_0 e^2 \hbar^2}{m_e^2 r^3} \sqrt{\frac{3}{4}} \quad (2.91)$$

For  $n = 2$ , the radius is  $r = 2a_0$ , and the predicted energy difference between the  ${}^2P_{3/2}$  and  ${}^2P_{1/2}$  levels of the hydrogen atom is

$$E_{s/o} = \frac{\alpha \pi \mu_0 e^2 \hbar^2}{8 m_e^2 a_0^3} \sqrt{\frac{3}{4}} \quad (2.92)$$

wherein  $\ell = 1$ .  $E_{s/o}$  may be expressed in terms of the mass energy of the electron.

$$E_{s/o} = \frac{\alpha^5 (2\pi)^2}{8} m_e c^2 \sqrt{\frac{3}{4}} \quad (2.95)$$

The energy called the fine structure splitting is 10,934.3 MHz. The  ${}^2P_{3/2}$  and  ${}^2P_{1/2}$  levels are also split by spin-nuclear and orbital-nuclear coupling. The calculated  ${}^2P_{3/2} - {}^2P_{1/2}$  transition frequency including a transition between hyperfine levels is 10,975.7 MHz. The large natural widths of the hydrogen 2p levels limits the experimental accuracy. The experimental value of the  ${}^2P_{3/2} - {}^2P_{1/2}$  transition frequency is 10,969.1 MHz.

$\frac{e}{m_e}$  is not invariant under QM since the charge is invariant, but the mass is not; so, there

are serious problems in applying special relativity to QM. And, QM has many problems calculating the electron g factor as discussed in # 7 of this Response and in Ref. [1]. Infinities arise from the self fields which require arbitrary renormalization algorithms and the so-called physics involves polarization of the vacuum by virtual particles which is not based in reality.

Regarding the Examiner's position that accelerating charge must give rise to radiation. The Examiner misses the point entirely that Applicant solves for the charge and current-density functions of the electron rather than probability-wave functions. And, the electron is an extended particle, not a point particle as is the case in QM (the QM point particle has many problems including the prediction of infinite fields which are nonphysical and have never been observed). In the case that  $n=1$ , the Examiner is incorrectly arguing that there is radiation in the magnetostatic and electrostatic case.

From Appendix I of Ref. [1] where the embedded references correspond to those of Appendix I of Ref. [1]:

## THE POYNTING POWER VECTOR

A point charge undergoing periodic motion accelerates and as a consequence radiates according to the Larmor formula:

$$P = \frac{1}{4\pi\epsilon_0} \frac{2e^2}{3c^3} a^2 \quad (1)$$

where  $e$  is the charge,  $a$  is its acceleration,  $\epsilon_0$  is the permittivity of free space, and  $c$  is the speed of light. Although an accelerated *point* particle radiates, an *extended distribution* modeled as a superposition of accelerating charges does not have to radiate<sup>143</sup>. An ensemble of charges, all oscillating at the same frequency, create a radiation pattern with a number of nodes. The same applies to current patterns in phased array antenna design [43]. It is possible to have an infinite number of charges oscillating in such a way as to cause destructive interference or nodes in all directions. The electromagnetic far field is determined from the current distribution in order to obtain the condition, if it exists, that the electron current distribution given by Eq. (6) must satisfy such that the electron does not radiate.

The charge-density functions of the electron orbitsphere in spherical coordinates plus time are given by Eqs. (1.64-1.65). For  $\ell = 0$ ,  $N = \frac{-e}{8\pi r_n^2}$ , and the charge-density function is

$$\rho(r, \theta, \phi, t) = \frac{e}{8\pi r_n^2} [\delta(r - r_n)] [Y_0^0(\theta, \phi) + Y_\ell^m(\theta, \phi)] \quad (2)$$

The equipotential, uniform or constant charge-density function (Eq. (1.64) and Eq. (2)) further comprises a current pattern given in the ORBITSPHERE EQUATION OF MOTION FOR  $\ell = 0$  section. It also corresponds to the nonradiative  $n = 1$ ,  $\ell = 0$  state of atomic hydrogen and to the spin function of the electron. The current-density function is given by multiplying Eq. (2) by the constant angular velocity  $\omega_n$ . There is acceleration without radiation. In this case, centripetal acceleration. A static charge distribution exists even though each point on the surface is accelerating along a great circle. Haus' condition predicts no radiation for the entire ensemble. The same result is trivially predicted from consideration of the fields and the radiated power. Since the current is not time dependent, the fields are given by

<sup>143</sup> Reference Nos. 1, 11, 15, 41-42

$$\nabla \times \mathbf{H} = \mathbf{J} \quad (3)$$

and

$$\nabla \times \mathbf{E} = 0 \quad (4)$$

which are the electrostatic and magnetostatic cases, respectively, with no radiation.

A summary of the stability derivation for p, d, f, etc.. orbitals based on the Haus condition given in Chp. 1 of Ref. [1] is

### Nonradiation Based on the Spacetime Fourier Transform of the Electron Current

Although an accelerated *point* particle radiates, an *extended distribution* modeled as a superposition of accelerating charges does not have to radiate. The spacetime Fourier transform of the current-density function is

$$K(s, \Theta, \Phi, \omega) = 4\pi\omega_n \frac{\sin(2sr_n)}{2sr_n} \otimes 2\pi \sum_{\nu=1}^{\infty} \frac{(-1)^{\nu-1} (\pi \sin \Theta)^{2(\nu-1)}}{(\nu-1)!(\nu-1)!} \frac{\Gamma\left(\frac{1}{2}\right) \Gamma\left(\nu + \frac{1}{2}\right)}{(\pi \cos \Theta)^{2\nu+1} 2^{\nu+1}} \frac{2\nu!}{(\nu-1)!} s^{-2\nu}$$

$$\otimes 2\pi \sum_{\nu=1}^{\infty} \frac{(-1)^{\nu-1} (\pi \sin \Phi)^{2(\nu-1)}}{(\nu-1)!(\nu-1)!} \frac{\Gamma\left(\frac{1}{2}\right) \Gamma\left(\nu + \frac{1}{2}\right)}{(\pi \cos \Phi)^{2\nu+1} 2^{\nu+1}} \frac{2\nu!}{(\nu-1)!} s^{-2\nu} \frac{1}{4\pi} [\delta(\omega - \omega_n) + \delta(\omega + \omega_n)]$$

$$\mathbf{s}_n \bullet \mathbf{v}_n = \mathbf{s}_n \bullet \mathbf{c} = \omega_n$$

The relativistically corrected wavelength is

$$\lambda_n = r_n$$

Spacetime harmonics of  $\frac{\omega_n}{c} = k$  or  $\frac{\omega_n}{c} \sqrt{\frac{\epsilon}{\epsilon_0}}$  for which the Fourier transform of the current-

density function is nonzero do not exist. Radiation due to charge motion does not occur in any medium when this condition is met.

Haus, H. A., "On the radiation from point charges", American Journal of Physics, 54, (1986), pp. 1126-1129.

Abbott, T. A., Griffiths, D. J., Am. J. Phys., Vol. 153, No. 12, (1985), pp. 1203-1211.

G. Goedecke, Phys. Rev 135B, (1964), p. 281.

A summary of the stability derivation based on the Poynting Power Vector given in Chp. 1, Appendix I of Ref. [1] is

### Nonradiation Based on the Electron Electromagnetic Fields and the Poynting Power Vector

Although an accelerated *point* particle radiates, an *extended distribution* modeled as a superposition of accelerating charges does not have to radiate. The general multipole field solution to Maxwell's equations in a source-free region of empty space with the assumption of a time dependence  $e^{i\omega_n t}$  is

$$\begin{aligned} \mathbf{B} &= \sum_{\ell, m} \left[ a_E(\ell, m) f_\ell(kr) \mathbf{X}_{\ell, m} - \frac{i}{k} a_M(\ell, m) \nabla \times g_\ell(kr) \mathbf{X}_{\ell, m} \right] \\ \mathbf{E} &= \sum_{\ell, m} \left[ \frac{i}{k} a_E(\ell, m) \nabla \times f_\ell(kr) \mathbf{X}_{\ell, m} + a_M(\ell, m) g_\ell(kr) \mathbf{X}_{\ell, m} \right] \end{aligned} \quad (1)$$

For the electron source current comprising a multipole of order  $(\ell, m)$ , the far fields are given by

$$\begin{aligned} \mathbf{B} &= -\frac{i}{k} a_M(\ell, m) \nabla \times g_\ell(kr) \mathbf{X}_{\ell, m} \\ \mathbf{E} &= a_M(\ell, m) g_\ell(kr) \mathbf{X}_{\ell, m} \end{aligned} \quad (2)$$

and the time-averaged power radiated per solid angle  $\frac{dP(\ell, m)}{d\Omega}$  is

$$\frac{dP(\ell, m)}{d\Omega} = \frac{c}{8\pi k^2} |a_M(\ell, m)|^2 |\mathbf{X}_{\ell, m}|^2 \quad (3)$$

where  $a_M(\ell, m)$  is

$$a_M(\ell, m) = \frac{-ek^2}{c\sqrt{\ell(\ell+1)}} \frac{\omega_n}{2\pi} N_{j_\ell}(kr_n) \Theta \sin(mks) \quad (4)$$

In the case that  $k$  is the lightlike  $k^0$ , then  $k = \omega_n / c$ , in Eq. (4), and Eqs. (2-3) vanishes for

$$s = vT_n = R = r_n = \lambda_n \quad (5)$$

There is no radiation.

Regarding FN 2. The relativistic correction to the electron radius is derived in the Special Relativistic Correction to the Ionization Energies section of Chp. 1, Ref. [1]. A summary of the relativistic correction to the electron radius is:

### Special Relativistic Correction to the Electron Radius

The relationship between the electron wavelength and its radius is given by

$$2\pi r = \lambda$$

where  $\lambda$  is the de Broglie wavelength.

The distance along each great circle in the direction of instantaneous motion undergoes length contraction and time dilation. Using a phase matching condition, the wavelengths of the electron and laboratory inertial frames are equated, and the corrected radius is given by

$$r_n = r_n' \left[ \sqrt{1 - \left(\frac{v}{c}\right)^2} \sin \left[ \frac{\pi}{2} \left( 1 - \left(\frac{v}{c}\right)^2 \right)^{3/2} \right] + \frac{1}{2\pi} \cos \left[ \frac{\pi}{2} \left( 1 - \left(\frac{v}{c}\right)^2 \right)^{3/2} \right] \right]$$

where the electron velocity is given by

$$v_n = \frac{\hbar}{m_e r_n}$$

$\frac{e}{m_e}$  of the electron, the electron angular momentum of  $\hbar$ , and  $\mu_B$  are invariant, but the mass and charge densities increase in the laboratory frame due to the relativistically contracted electron radius. As  $v \rightarrow c$ ,  $r/r' \rightarrow \frac{1}{2\pi}$  and  $r = \lambda$ .

Applicant agrees with the Examiner that a valid theory of the hydrogen atom can not be correct if it requires that the electron in the nucleus. Thus QM is fatally flawed as discussed in Ref. [17, 80]. A valid theory can not permit the electron to "spiral into the nucleus". However, an inescapable fact of QM is that the wave function solution of the SE requires that **the electron is in the nucleus**<sup>144</sup>. In fact, the electron must exist in the nucleus since the wave function is a maximum there. This is clearly claimed in the literature as discussed by Karplus to explain the spin-nuclear coupling called Fermi contact interaction for example [ M. Karplus and R. N. Porter, *Atoms and Molecules an Introduction for Students of Physical Chemistry*, The Benjamin/Cummings Publishing Company, Menlo Park, California, (1970), p. 567]. In fact, the probability density function  $\Psi^2$  has a maximum at the nucleus for the n=1 state, and the nucleus has a finite volume. Griffiths gives the time average that the electron is in the nucleus [D. J. Griffiths, *Introduction to Quantum Mechanics*, Prentice-Hall, (1995), Prob. 4.14]. This situation corresponds to infinite energy using Feynman's correct assertion<sup>145</sup> that the Coulomb potential

<sup>144</sup> Reference Nos. 17, 80

<sup>145</sup> Reference No. 80

must apply to the interaction of the electron and the nucleus.

## Conclusion

Applicant has more than met the burden for the issuance of a patent based on the overwhelming experimental evidence presented in the section of Applicant's main response entitled "**Lower-Energy Hydrogen Experimental Data**," given that CQM works better than QM and is based on physical laws rather than pure mathematics as given and discussed in:

94. R. L. Mills, "The Nature of the Chemical Bond Revisited and an Alternative Maxwellian Approach", J. Phys. D, submitted.
80. R. L. Mills, The Fallacy of Feynman's Argument on the Stability of the Hydrogen Atom According to Quantum Mechanics, Foundations of Physics, submitted.
58. R. L. Mills, "Classical Quantum Mechanics", Physics Essays, submitted.
53. R. Mills, "A Maxwellian Approach to Quantum Mechanics Explains the Nature of Free Electrons in Superfluid Helium", Theoretical Chemistry Accounts, submitted.
22. R. Mills, "The Grand Unified Theory of Classical Quantum Mechanics", Global Foundation, Inc. Orbis Scientiae entitled *The Role of Attractive and Repulsive Gravitational Forces in Cosmic Acceleration of Particles The Origin of the Cosmic Gamma Ray Bursts*, (29th Conference on High Energy Physics and Cosmology Since 1964) Dr. Behram N. Kursunoglu, Chairman, December 14-17, 2000, Lago Mar Resort, Fort Lauderdale, FL, Kluwer Academic/Plenum Publishers, New York, pp. 243-258.
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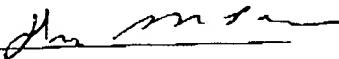


## DECLARATION OF DR. RANDELL L. MILLS

I, Randell L. Mills, declare and state as follows:

1. I am the founder and CEO of BlackLight Power, Inc., located at 493 Old Trenton Road, Cranbury, New Jersey 08512.
2. I majored in chemistry and received my bachelor of arts degree, *summa cum laude* and Phi Beta Kappa, from Franklin & Marshall College in 1982. I received a medical degree from Harvard Medical School in 1986. While attending Harvard Medical School, I concurrently spent a year taking courses in advanced electrical engineering at the Massachusetts Institute of Technology. I have also had significant academic training in biology, chemistry, mathematics and physics.
3. I began my research in the field of energy technology over ten years ago. I have authored, co-authored or collaborated on numerous publications, reports and presentations at scientific meetings in the field of energy technology and novel hydrogen chemistry, as shown in the attachment hereto.
4. I am fully qualified to conduct the research that led to the discovery and development of BlackLight's lower-energy hydrogen technology.
5. I personally conducted and/or supervised the experimental data disclosed in the articles submitted to the U.S. Patent and Trademark Office ("PTO"), which are described in the attached list. The coauthors, if any, assisted me in preparing the data.

I declare further that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

By   
Dr. Randell L. Mills

Date: July 25, 2005

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114. R. Mills, K. Akhtar, B. Dhandapani, "Tests of Features of Field-Acceleration Models for the Extraordinary Selective H Balmer  $\alpha$  Broadening in Certain Hydrogen Mixed Plasmas", Journal of Applied Physics, submitted.
113. R. Mills, "Physical Solutions of the Nature of the Atom, Photon, and Their Interactions to Form Excited and Predicted Hydrino States", New Journal of Physics, submitted.
112. R. L. Mills, J. He, Y. Lu, M. Nansteel, Z. Chang, B. Dhandapani, "Comprehensive Identification and Potential Applications of New States of Hydrogen", Central European Journal of Physics, submitted.
111. R. Mills, J. He, Z. Chang, W. Good, Y. Lu, B. Dhandapani, "Catalysis of Atomic Hydrogen to Novel Hydrogen Species  $H^-(1/4)$  and  $H_2(1/4)$  as a New Power Source", Thermochemica Acta, submitted.
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103. R. Mills, B. Dhandapani, W. Good, J. He, "New States of Hydrogen Isolated from  $K_2CO_3$  Electrolysis Gases", Chemical Engineering Science, submitted.
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100. R. Mills, B. Dhandapani, J. He, "Highly Stable Amorphous Silicon Hydride from a Helium Plasma Reaction", Materials Chemistry and Physics, submitted.
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5. R. Mills, "The Hydrogen Atom Revisited", *Int. J. of Hydrogen Energy*, Vol. 25, Issue 12, December, (2000), pp. 1171-1183.
4. R. Mills, W. Good, "Fractional Quantum Energy Levels of Hydrogen", *Fusion Technology*, Vol. 28, No. 4, November, (1995), pp. 1697-1719.
3. R. Mills, W. Good, R. Shaubach, "Dihydrino Molecule Identification", *Fusion Technology*, Vol. 25, (1994), pp. 103-119.
2. R. Mills, S. Kneizys, *Fusion Technol.* Vol. 20, (1991), pp. 65-81.
1. R. Mills, *The Grand Unified Theory of Classical Quantum Mechanics*, September 2001 Edition, BlackLight Power, Inc., Cranbury, New Jersey, Distributed by Amazon.com; January 2004 Edition posted at [www.blacklightpower.com](http://www.blacklightpower.com).

### **Book Publications**

8. R. Mills, *The Grand Unified Theory of Classical Quantum Mechanics*, January 2003 Edition, BlackLight Power, Inc., Cranbury, New Jersey, posted at [www.blacklightpower.com](http://www.blacklightpower.com).
7. R. Mills, *The Grand Unified Theory of Classical Quantum Mechanics*, September 2001 Edition, BlackLight Power, Inc., Cranbury, New Jersey, Distributed by Amazon.com.

6. R. Mills, *The Grand Unified Theory of Classical Quantum Mechanics*, January 2000 Edition, BlackLight Power, Inc., Cranbury, New Jersey
5. R. Mills, *The Grand Unified Theory of Classical Quantum Mechanics*, January 1999 Edition.
4. R. Mills, *The Grand Unified Theory of Classical Quantum Mechanics*, September 1996 Edition.
3. R. Mills, *The Grand Unified Theory of Classical Quantum Mechanics*, (1995), Technomic Publishing Company, Lancaster, PA provided by HydroCatalysis Power Corporation, Great Valley Corporate Center, 41 Great Valley Parkway, Malvern, PA 19355
2. R. Mills, *The Unification of Spacetime, the Forces, Matter, and Energy*, Technomic Publishing Company, Lancaster, PA, (1992).
1. R. Mills, J. Farrell, *The Grand Unified Theory*, Science Press, Ephrata, PA, (1990).

### **Correspondence**

5. R. Mills, "One Dimension Gravity Well—A Flawed Interpretation", response to V. V. Nesvizhevsky , Scientific American, submitted.
4. R. Mills, Response to W. Seifritz, Int J of Hydrogen Energy, Vol. 28, No. 3, (2003), pp. 359-360.
3. R. Mills, Response to T. Ohta, Int J of Hydrogen Energy, Vol. 26, No. 11, (2001), pp. 1225.
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### **Test Reports**

Numerous test reports are available from BlackLight Power (e.g. Haldeman, C. W., Savoye, G. W., Iseler, G. W., Clark, H. R., MIT Lincoln Laboratories Excess Energy Cell Final report ACC Project 174 (3), April 25, 1995; Peterson, S., H., Evaluation of Heat Production from Light Water Electrolysis Cells of HydroCatalysis Power Corporation, Report from Westinghouse STC, 1310 Beulah Road, Pittsburgh, PA, February 25, 1994; Craw-Ivanco, M. T.; Tremblay, R. P.; Boniface, H. A.; Hilborn, J. W.; "Calorimetry for a Ni/K<sub>2</sub>CO<sub>3</sub> Cell", Atomic Energy

Canada Limited, Chemical Engineering Branch, Chalk River Laboratories, Chalk River, Ontario, June 1994; Nesterov, S. B., Kryukov, A. P., Moscow Power Engineering Institute Affidavit, February, 26, 1993; Jacox, M. G., Watts, G. R., "The Search for Excess Heat in the Mills Electrolytic Cell", Idaho National Engineering Laboratory, EG&G Idaho, Inc., Idaho Falls, Idaho, 83415, January 7, 1993; Gernert, N., Shaubach, R. M., Mills, R., Good, W., "Nascent Hydrogen: An Energy Source," Final Report prepared by Thermacore, Inc., for the Aero Propulsion and Power Directorate, Wright Laboratory, Air Force Material Command (ASC), Wright-Patterson Air Force Base, Contract Number F33615-93-C-2326, May, (1994); Phillips, J., Smith, J., Kurtz, S., "Report On Calorimetric Investigations Of Gas-Phase Catalyzed Hydrino Formation" Final report for Period October-December 1996", January 1, 1997, A Confidential Report submitted to BlackLight Power, Inc. provided by BlackLight Power, Inc., Great Valley Corporate Center, 41 Great Valley Parkway, Malvern, PA 19355; B. N. Popov, "Electrochemical Characterization of BlackLight Power, Inc. MH as Electrodes for Li-ion Batteries, Dept. of Chemical Engineering, University of South Carolina, February 6, 2000; Scores of Independent Tests of BlackLight Power's Novel Hydride Compounds from over 20 Independent Testing Laboratories.)

### **Upcoming Conference Presentations**

### **Prior Conference Presentations**

56. R. Mills, "The Grand Unified Theory of Classical Quantum Mechanics Workshop", at the University of Milano di Politecnico, Milan, Italy, Sponsored by the POLITECNICO Foundation, March 3, 2005.
55. R. Mills, "The Hydrino: Lower-level States of the Hydrogen Atom which Have Remarkable Consequences". Invited Evening Lecture at the 17th Symposium of Plasma Physics and Radiation Technology, sponsored by the Netherlands' Physical Society Section Plasma and Gas Discharge Physics and Research School Center for Plasma Physics and Radiation Technology, Lunteren, Netherlands, March 1-2, 2005.
54. R. Mills, "The Grand Unified Theory of Classical Quantum Mechanics Workshop", at the University of Eindhoven, Netherlands, February 28, 2005.

53. R. L. Mills, Y. Lu, M. Nansteel, J. He, A. Voigt, W. Good, B. Dhandapani, "Energetic Catalyst-Hydrogen Plasma Reaction as a Potential New Energy Source", Division of Fuel Chemistry, Session: Advances in Hydrogen Energy, 228th American Chemical Society National Meeting, August 22-26, 2004, Philadelphia, PA.
52. R. L. Mills, BlackLight Power A New Energy Source, Volta Institute, June 25, 2004, Como, Italy.
51. R. L. Mills, Y. Lu, M. Nansteel, J. He, A. Voigt, B. Dhandapani, "Energetic Catalyst-Hydrogen Plasma Reaction as a Potential New Energy Source", Division of Fuel Chemistry, Session: Chemistry of Solid, Liquid, and Gaseous Fuels, 227th American Chemical Society National Meeting, March 28-April 1, 2004, Anaheim, CA.
50. R. L. Mills, P. Ray, M. Nansteel, J. He, X. Chen, A. Voigt, B. Dhandapani, "Energetic Catalyst-Hydrogen Plasma Reaction as a Potential New Energy Source," (Division of Industrial and Engineering Chemistry Symposium), September 9, 2003, 226<sup>th</sup> American Chemical Society National Meeting, (Sept. 7-11, 2003), New York, NY.
49. B. Dhandapani, R. Mills, "Novel Liquid-Nitrogen-Condensable Molecular Hydrogen Gas" (Physical Chemistry Session) , Wednesday, June 11, 2003, 36<sup>th</sup> Middle Atlantic Regional Meeting of American Chemical Society, (June 8-11, 2003), Princeton University, Princeton, NJ.
48. P. Ray, R. Mills, "Extreme Ultraviolet Spectroscopy of Helium-Hydrogen Plasma" (Physical Chemistry Session) , Wednesday, June 11, 2003, 36<sup>th</sup> Middle Atlantic Regional Meeting of American Chemical Society, (June 8-11, 2003), Princeton University, Princeton, NJ.
47. R. Mills, "Novel Catalytic Reaction Of Hydrogen as a Potential New Energy Source" (Catalysis Session), Tuesday, June 10, 2003, 36<sup>th</sup> Middle Atlantic Regional Meeting of American Chemical Society, (June 8-11, 2003), Princeton University, Princeton, NJ.
46. J. He, R. Mills, "TOF-SIMS and XPS Studies of Highly Stable Silicon Hydride Films" (Inorganic/Solid State Session), Monday, June 9, 2003, 36<sup>th</sup> Middle Atlantic Regional Meeting of American Chemical Society, (June 8-11, 2003), Princeton University, Princeton, NJ.
45. B. Dhandapani, R. Mills, "Low Power MPCVD Synthesis and Characterization of Diamond Films on Silicon Substrates" (Inorganic/Solid State Session) , Monday,

- June 9, 2003, 36<sup>th</sup> Middle Atlantic Regional Meeting of American Chemical Society, (June 8–11, 2003), Princeton University, Princeton, NJ.
44. X. Chen, R. Mills, "Calorimetric Study of Heat Generation by Catalytic Reaction of Atomic Hydrogen in Resonant Transfer Plasmas" (Fuel Cells Session) , Monday, June 9, 2003, 36<sup>th</sup> Middle Atlantic Regional Meeting of American Chemical Society, (June 8–11, 2003), Princeton University, Princeton, NJ.
43. R. L. Mills, "Novel Catalytic Reaction of Hydrogen as a Potential New Energy Source", Division of Industrial and Engineering Chemistry, "Green Chemistry in the Design of Alternative Energy Strategies", symposium, Oral Presentation, 225<sup>th</sup> ACS National Meeting, (March 23-27, 2003), New Orleans, LA.
42. R. L. Mills, "Novel Catalytic Reaction of Hydrogen as a Potential New Energy Source", Monday, November 25, Room 216, Protocol Center, TA-3, Los Alamos National Laboratory.
41. R. L. Mills, "Classical Quantum Mechanics", Monday, November 25, Room 216, Protocol Center, TA-3, Los Alamos National Laboratory.
40. R. L. Mills, Seminar: "Novel Catalytic Reaction of Hydrogen as a Potential New Energy Source", US Environmental Protection Agency, National Risk Management Research Laboratory, Sustainable Technologies Division, Cincinnati, OH, October 24, 2002.
39. R. L. Mills, J. Dong, J. He, B. Dhandapani, A. Voigt, M. Nansteel, J. Sankar, R. M. Mayo, P. Ray, "Novel Catalytic Reaction of Hydrogen as a Potential New Energy Source", Division of Inorganic Chemistry, Oral Presentation, 224<sup>rd</sup> ACS National Meeting, (August 18-22, 2002), Boston, MA (Aug. 22, 4:10-4:30 PM).
38. R. L. Mills, J. Dong, J. He, B. Dhandapani, A. Voigt, M. Nansteel, J. Sankar, R. M. Mayo, P. Ray, "Novel Catalytic Reaction of Hydrogen as a Potential New Energy Source", Division of Colloidal and Surface Chemistry, Oral Presentation, 224<sup>rd</sup> ACS National Meeting, (August 18-22, 2002), Boston, MA (Aug. 22, 8:30-8:50 AM).
37. P. Ray, R. Mills, "Spectroscopic Characterization of Stationary Inverted Balmer and Lyman Populations Formed by a Catalytic Reaction of Atomic Hydrogen with Oxygen and with Certain Group I Catalysts", Eighteenth International Conference on Atomic Physics, July 28-August 2, 2002, Cambridge, Massachusetts.
36. R. M. Mayo, R. L. Mills, M. Nansteel, "Direct Plasmadynamic Conversion of Plasma Thermal Power from a Novel Plasma Source to Electricity for Microdistributed Power Applications", 40<sup>th</sup> Power Sources Conference, (June 6–13, 2002), Cherry Hill, NJ.

35. R. L. Mills, J. Dong, J. He, B. Dhandapani, W. Good, A. Voigt, S. Hicks, M. Nansteel, E. Dayalan, P. Ray, "Spectroscopic Identification of a Novel Catalytic Reaction of Hydrogen", Division of Inorganic Chemistry, Oral Presentation, 223<sup>rd</sup> ACS National Meeting, (April 7-11, 2002), Orlando, FL.
34. R. L. Mills, J. Dong, J. He, B. Dhandapani, W. Good, A. Voigt, S. Hicks, M. Nansteel, E. Dayalan, P. Ray, "Novel Catalytic Reaction of Hydrogen as a Potential New Energy Source", Division of Inorganic Chemistry, Oral Presentation, 223<sup>rd</sup> ACS National Meeting, (April 7-11, 2002), Orlando, FL.
33. R. L. Mills, J. Dong, J. He, B. Dhandapani, W. Good, A. Voigt, S. Hicks, M. Nansteel, E. Dayalan, P. Ray, "Novel Catalytic Reaction of Hydrogen as a Potential New Energy Source", Division of Industrial and Engineering Chemistry, Oral Presentation, 223<sup>rd</sup> ACS National Meeting, (April 7-11, 2002), Orlando, FL.
32. R. L. Mills, J. Dong, J. He, B. Dhandapani, W. Good, A. Voigt, S. Hicks, M. Nansteel, E. Dayalan, P. Ray, "Novel Catalytic Reaction of Hydrogen as a Potential New Energy Source", Catalysis and Surface Science Secretariat, Oral Presentation, 223<sup>rd</sup> ACS National Meeting, (April 7-11, 2002), Orlando, FL.
31. R. L. Mills, J. Dong, J. He, B. Dhandapani, W. Good, A. Voigt, S. Hicks, M. Nansteel, E. Dayalan, P. Ray, "Novel Catalytic Reaction of Hydrogen as a Potential New Energy Source", Division of Physical Chemistry, Poster Presentation, 223<sup>rd</sup> ACS National Meeting, (April 7-11, 2002), Orlando, FL.
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29. R. Mills, "BlackLight Power Technology-A New Clean Energy Source with the Potential for Direct Conversion to Electricity", *The 8<sup>th</sup> Annual Emerald Groundhog Day Investment Forum*, February 5, 2002, Wyndham Franklin Plaza Hotel, Philadelphia, PA, Organized by Emerald Asset Management, Lancaster, PA.
28. R. L. Mills, E. Dayalan, "Novel Alkali and Alkaline Earth Hydrides for High Voltage and High Energy Density Batteries", *Proceedings of the 17<sup>th</sup> Annual Battery Conference on Applications and Advances*, California State University, Long Beach, CA, (January 15-18, 2002), pp. 1-6.
27. P. Ray, R. Mills, "Spectroscopic identification of a novel catalytic reaction of hydrogen plasma", Session ET1: Lighting, American Physical Society Meeting,

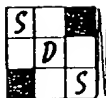


- 54th Annual Gaseous Electronics Conference, October 9–12, 2001, Pennsylvania State University, State College, PA.
26. R. Mills, "Novel catalytic reaction of hydrogen as a potential new energy source", Division of Industrial and Engineering Chemistry; Session: Industrial Bio-Based Technology, 222nd American Chemical Society Fall National Meeting, (August 26–30, 2001), Chicago, IL.
  25. R. Mills, "Spectroscopic identification of a novel catalytic reaction of hydrogen", Division of Inorganic Chemistry; Session: Catalysis, 222nd American Chemical Society Fall National Meeting, (August 26–30, 2001), Chicago, IL.
  24. R. Mills, "Spectroscopic identification of a novel catalytic reaction of hydrogen", Division of Physical Chemistry; Session: Physical Chemistry Poster Session, 222nd American Chemical Society Fall National Meeting, (August 26–30, 2001), Chicago, IL.
  23. R. Mills, J. He, "Spectroscopic Identification of a Novel Catalytic Reaction of Atomic Hydrogen and the Hydride Ion Product", National Hydrogen Association, 12 th Annual U.S. Hydrogen Meeting and Exposition, *Hydrogen: The Common Thread*, The Washington Hilton and Towers, Washington DC, (March 6-8, 2001).
  22. R. Mills, B. Dhandapani, M. Nansteel, N. Greenig, S. Hicks, J. Dong, "Optically Measured Power Balances of Anomalous Discharges of Mixtures of Argon, Hydrogen, and Potassium, Rubidium, Cesium, or Strontium Vapor", National Hydrogen Association, 12 th Annual U.S. Hydrogen Meeting and Exposition, *Hydrogen: The Common Thread*, The Washington Hilton and Towers, Washington DC, (March 6-8, 2001).
  21. R. Mills, M. Nansteel, N. Greenig, S. Hicks, "BlackLight Power Technology-A New Clean Energy Source with the Potential for Direct Conversion to Electricity", National Hydrogen Association, 12 th Annual U.S. Hydrogen Meeting and Exposition, *Hydrogen: The Common Thread*, The Washington Hilton and Towers, Washington DC, (March 6-8, 2001).
  20. R. Mills, B. Dhandapani, M. Nansteel, J. He, A. Voigt, "Identification of Compounds Containing Novel Hydride Ions by Nuclear Magnetic Resonance Spectroscopy", National Hydrogen Association, 12 th Annual U.S. Hydrogen Meeting and Exposition, *Hydrogen: The Common Thread*, The Washington Hilton and Towers, Washington DC, (March 6-8, 2001).
  19. R. Mills, "BlackLight Power Technology-A New Clean Energy Source with the Potential for Direct Conversion to Electricity", *The 8 th Annual Emerald Groundhog*

*Day Investment Forum*, February 1, 2001, Wyndham Franklin Plaza Hotel, Philadelphia, PA, Organized by Emerald Asset Management, Lancaster, PA.

18. R. Mills, "The Grand Unified Theory of Classical Quantum Mechanics", Global Foundation, Inc. Orbis Scientiae entitled *The Role of Attractive and Repulsive Gravitational Forces in Cosmic Acceleration of Particles The Origin of the Cosmic Gamma Ray Bursts*, (29th Conference on High Energy Physics and Cosmology Since 1964) Dr. Behram N. Kursunoglu, Chairman, December 14-17, 2000, Lago Mar Resort, Fort Lauderdale, FL.
17. R. Mills, "BlackLight Power Technology-A New Clean Energy Source with the Potential for Direct Conversion to Electricity", Global Foundation, Inc. conference entitled *Global Warming and Energy Policy*, Fort Lauderdale, FL, November 26-28, 2000.
16. R. Mills, B. Dhandapani, N. Greenig, J. He, J. Dong, Y. Lu, and H. Conrads, "Formation of an Energetic Plasma and Novel Hydrides from Incandescently Heated Hydrogen Gas with Certain Catalysts", August National ACS Meeting (220th ACS National Meeting, Washington, DC, (August 20-24, 2000)).
15. R. Mills, J. He, and B. Dhandapani, "Novel Alkali and Alkaline Earth Hydrides", August National ACS Meeting (220th ACS National Meeting, Washington, DC, (August 20-24, 2000)).
14. R. Mills, B. Dhandapani, N. Greenig, J. He, J. Dong, Y. Lu, and H. Conrads, "Formation of an Energetic Plasma and Novel Hydrides from Incandescently Heated Hydrogen Gas with Certain Catalysts", June ACS Meeting (29th Northeast Regional Meeting, University of Connecticut, Storrs, CT, (June 18-21, 2000)).
13. Mills, J. Dong, N. Greenig, and Y. Lu, "Observation of Extreme Ultraviolet Hydrogen Emission from Incandescently Heated Hydrogen Gas with Certain Catalysts", 219 th National ACS Meeting, San Francisco, California, (March 26-30, 2000).
12. R. Mills, B. Dhandapani, N. Greenig, J. He, J. Dong, Y. Lu, and H. Conrads, "Formation of an Energetic Plasma and Novel Hydrides from Incandescently Heated Hydrogen Gas with Certain Catalysts", 219 th National ACS Meeting, San Francisco, California, (March 26-30, 2000).
11. R. Mills, "Novel Hydride Compound", 219 th National ACS Meeting, San Francisco, California, (March 26-30, 2000).
10. R. Mills, J. He, and B. Dhandapani, "Novel Alkali and Alkaline Earth Hydrides", 219 th National ACS Meeting, San Francisco, California, (March 26-30, 2000).

9. R. Mills, J. Dong, N. Greenig, and Y. Lu, "Observation of Extreme Ultraviolet Hydrogen Emission from Incandescently Heated Hydrogen Gas with Certain Catalysts", National Hydrogen Association, 11 th Annual U.S. Hydrogen Meeting, Vienna, VA, (February 29-March 2, 2000).
8. R. Mills, B. Dhandapani, N. Greenig, J. He, J. Dong, Y. Lu, and H. Conrads, "Formation of an Energetic Plasma and Novel Hydrides from Incandescently Heated Hydrogen Gas with Certain Catalysts", National Hydrogen Association, 11 th Annual U.S. Hydrogen Meeting, Vienna, VA, (February 29-March 2, 2000).
7. R. Mills, "Novel Hydride Compound", National Hydrogen Association, 11 th Annual U.S. Hydrogen Meeting, Vienna, VA, (February 29-March 2, 2000).
6. R. Mills, J. He, and B. Dhandapani, "Novel Alkali and Alkaline Earth Hydrides", National Hydrogen Association, 11 th Annual U.S. Hydrogen Meeting, Vienna, VA, (February 29-March 2, 2000).
5. R. Mills, J. Dong, Y. Lu, J. Conrads, "Observation of Extreme Ultraviolet Hydrogen Emission from Incandescently Heated Hydrogen Gas with Certain Catalysts", 1999 Pacific Conference on Chemistry and Spectroscopy and the 35th ACS Western Regional Meeting, Ontario Convention Center, California, (October 6-8, 1999).
4. R. Mills, "Novel Hydride Compound", 1999 Pacific Conference on Chemistry and Spectroscopy and the 35th ACS Western Regional Meeting, Ontario Convention Center, California, (October 6-8, 1999).
3. R. Mills, B. Dhandapani, N. Greenig, J. He, "Synthesis and Characterization of Potassium Iodo Hydride", 1999 Pacific Conference on Chemistry and Spectroscopy and the 35th ACS Western Regional Meeting, Ontario Convention Center, California, (October 6-8, 1999).
2. R. Mills, J. He, and B. Dhandapani, "Novel Hydrogen Compounds", 1999 Pacific Conference on Chemistry and Spectroscopy and the 35th ACS Western Regional Meeting, Ontario Convention Center, California, (October 6-8, 1999).
1. R. Mills, "Excess Heat Production by the Electrolysis of an Aqueous Potassium Carbonate Electrolyte", August 1991 meeting of the American Chemical Society, NY, NY.



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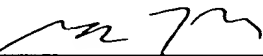
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## DECLARATION OF DR. GARY L. TURNER

I, Gary L. Turner, declare and state that:

1. I received a Bachelor of Science degree in Chemistry from the University of Illinois, Urbana, Illinois in 1978 and a Doctorate degree in Physical Chemistry at the University of Arkansas, Fayetteville, Arkansas in 1982.
2. From July 1982 to June 1988, I was a research associate for Dr. E. Oldfield, at the University of Illinois, Urbana, Illinois.
3. From August 1985 to the present, I have been employed by Spectral Data Services, Inc., where my duties include obtaining Nuclear-Magnetic-Resonance data on sample materials.
4. From April 1986 to August 1990 I was also employed as the Vice-President of Probe Systems, Inc., where I was responsible for designing Nuclear-Magnetic-Resonance (NMR) equipment.
5. I have published 38 peer-reviewed scientific papers, a list of which is shown in the Attachment.
6. Over the last year, I obtained  $^1\text{H}$  MAS NMR data on about 300 blind samples of compounds provided by BlackLight Power, Inc.
7. A 270 MHz NMR Spectrometer, operating at a Larmor frequency of 270.6196 MHz was used. The spectrometer was equipped with a Tecmag operating system and Henry Radio amplifiers for pulse generation. The probe was a 7 mm Doty Scientific Standard Probe. The data was collected with a pulse angle of about  $15^\circ$ , with a two second delay between pulses. The samples were spun at two speeds, usually at 4.5 and 3.5 KHz, to identify the spinning sidebands. Typically, 200 transients were collected for each spectrum. The data was processed using NUTS (Acorn NMR, Inc.) software.
8. Some of the samples showed signals in regions that are not typical. Most  $^1\text{H}$  MAS NMR signals are observed from about 10 to 0 ppm, where ppm represents the shift from the chemical shift standard, tetramethylsilane. Signals for BLP samples were observed at -4 to -5 ppm. Since 1978, I have been primarily conducting NMR scans and I have never observed signals in the region of -4 to -5 ppm before.

9. For sample 080304BLP1, in the  $^1\text{H}$  MAS NMR spectrum two unusual signals were observed, at -4.1 and -4.5 ppm. The only compounds known to have chemical shifts in this region are transition metal hydrides, in particular  $\text{Mg}_2\text{NiH}_4$ . Elemental analysis (Galbraith Laboratories, Inc., Knowville, TN) showed that Mg and Ni are not detected in this sample, and that K was the main metal present. Earlier NMR data has shown that the hydride of K appears at about 1.0 ppm. Therefore, these results suggest that the signals at -4.1 and -4.5 ppm represent a novel species, and do not correspond to any known metal hydride.
10. I declare further that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

By   
Dr. Gary L. Turner

Date: 8/24/04

## DECLARATION OF DR. BALA DHANDAPANI

I, Bala Dhandapani, residing at 30 Marion Circle, Eastampton, NJ 08060, declare and state that:

1. I received a Bachelor of Science Degree in Chemical Engineering from Anna University, Madras, India. I received a Doctorate Degree in Chemical Engineering in 1993 and a Masters of Science Degree in Chemical Engineering in 1990 from the Clarkson University, Potsdam, NY.

2. From 1997 to present, I have been employed as a Project Manager at BlackLight Power Inc., Cranbury, NJ, where I manage and conduct synthesis and characterization of novel hydride compounds.

3. From 1994-1997, I was employed as a Postdoctoral Research Associate and Laboratory Coordinator at Virginia Tech, Blacksburg, VA, Environmental Catalysis and Materials Laboratory, where I conducted synthesis, characterization, testing and development of novel catalytic materials for various environmentally significant reactions. I also managed the research activities of the lab of 12 researchers, including doctoral, masters and undergraduate students.

4. From 1990 - 1993, I was employed as a Research Assistant at Clarkson University, Potsdam, NY, wherein I studied the application of foam and monolith substrates for environmental catalysis. I also designed and constructed a reactor system with advanced instrumentation.

5. From 1988-1990, I was employed as an Instructor/Teaching Assistant at Clarkson University, where I taught the following courses: Unit Operations Laboratory, Reaction Engineering and Analysis, Advanced Reactor Design, Heterogeneous Catalysis, Material Science and Corrosion Engineering Laboratory.

6. I am experienced on the following instrumentation: AMETEK Quad Mass Spectrometer; Varian 3700 Gas Chromatograph; ISI-40 Scanning Electron Microscope; Siemens D 500 X-ray Diffractometer; Micromeritics ASAP 2010 Chemi; CHNS-EA1180 Elemental Analyzer; Perkin Elmer PHI 5300 ESCA; BioRad FT-60 Infrared spectroscopy; Mariner ESI-ToF Mass Spectrometer; HP 5890 and 6890 Gas Chromatograph; HP1100 HPLC; and Kratos XSAM800 XPS.

7. My research experience includes the synthesis of novel materials including: high surface area catalytic materials including monometallic and bimetallic transition metal carbides, nitrides, phosphides, hydrides and sulfides; noble metals and transition metal oxides; active catalytic materials supported on alumina, activated carbon, silica and titania; and high surface area activated carbon and silica from various precursors.

8. My research experience also includes the characterization of materials using the following techniques: X-ray diffraction; X-ray photoelectron spectroscopy; FTIR spectroscopy; Electrospray Ionization Time of Flight Mass Spectroscopy; Time of Flight Secondary Ion Mass Spectroscopy; Solids Probe Mass Spectroscopy (Quadrupole,

Magnetic Sector and Time of Flight); Proton Nuclear Magnetic Resonance; Scanning Electron Microscopy; Physisorption and Chemisorption techniques; Temperature programmed experiments; and Conductivity measurements Inductively Coupled Plasma Mass Spectrometry (elemental analysis).

9. My research experience further includes the development of catalytic materials, including: Optimization of synthesis conditions; Inclusion of additives, stabilizers and binders; and Fabrication of catalysts on monolith and foam substrates.

10. My research experience further includes the testing and evaluation of catalysts, including: Ozone decomposition reaction; Hydrogenation of aromatic compounds; Hydrodenitrogenation (HDN), hydrodesulfurization (HDS), hydrodeoxygenation (HDO) of various model compounds at high pressure reaction conditions; Hydrodechlorination (HDC) of chlorofluorocarbons; and Reforming of methane using membrane and plug flow reactors.

11. My research experience further includes kinetics and mechanism, including: Catalytic ozone decomposition reaction; Hydrogenation of isopropyl benzene; Simultaneous HDN, HDS and HDO of various heterocyclic aromatic compounds; and Hydrodechlorination of CFC-12 to HCFC-22 and HFC-32.

12. A selected list of my publications is attached.

13. I supervised the preparation of the compounds shown in the following Tables 1 and 2. Table 1 includes new compounds comprising hydrinos formed using catalysts for forming hydrinos (lower energy hydrogen) from hydrogen. The process used for forming the compounds comprising hydrinos is described in Dr. Randell L. Mills U.S. serial No. 09/009,294 and published PCT/US98/14029 application. Table 2 includes control compounds comprising conventional elements and energy states.

14. Blind samples of the compounds were sent to Dr. Gary L. Turner of Spectral Data Services, Inc. to conduct Nuclear-Magnetic-Resonance (NMR) evaluation of the samples. The results of the NMR analysis is shown in the Tables 1 and 2.

Summary of new hydrino hydride compounds that showed novel features with solid state MAS  $^1\text{H}$  NMR spectroscopy

Table 1

Compound	Data file	Reactants	$^1\text{H}$ NMR Features
KHI	blps00as.14	KI, K, $\text{H}_2$	-2.5*, 1.1
KHI	blps0095.005	K, KI, $\text{H}_2$	-3.2*, 0.9
KHCl	bpls99as.078	K, KCl, $\text{H}_2$	-4.4*, 4, 1.1
KHBr	bpls99as.058	K, KBr, $\text{H}_2$	-4.1*, 5.9, 4.3, 1.2
RbHF	bpls99as.034	RbF, K, $\text{H}_2$	-4.4*, 1.2

\* novel features

## Summary of relevant controls performed

Table 2

Control Compound	Data File	<sup>1</sup> H NMR Features
KH	blps00as.038	1.1, 0.8, 4.6
KH + KI	blps00as.099	1.1, 0.8, 4.5
KH + KCl	blps00as.097	1.1, 0.7, 4.3
KH + KBr	blps00as.101	1.1, 0.8, 4.2
RbH	textfr.1.txt	0.83, 4.0
RbH + RbF	blps00as.103	1.0, 4.9

1.1, 1.0, 0.8, 0.7 ppm is associated with M-H (where M is K or Rb),  
4-4.9 ppm is associated with M-OH (where M is K or Rb)

15. I analyzed XPS and TOFSIMS spectroscopy to determine the elements (cations and anions), such as the potassium and halides, present in each of the compounds. I also performed a Gas Chromatograph (GC) to determine whether hydrogen present in each of the compounds.

## CONCLUSIONS

16. Negative numbers in the compounds of Table 1 represent an upfield shift, which means that the electron is closer to the proton in the hydrogen. Thus, the upfield chemical shifts observed by the NMR data indicate that new lower energy states for the hydride ions (hydrino hydride ions) may exist.

17. I declare further that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

By D. Dhandapani  
Dr. Bala Dhandapani

Date: 8/18/2000



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Declaration of Dr. Bala Dhandapani

Page 5 of 5

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## DECLARATION OF DR. JONATHAN PHILLIPS

For: VERIFICATION OF POWER GENERATION BASED ON DR. RANDELL L. MILLS' HYDRINO TECHNOLOGY

I, Jonathan Phillips, residing at 700 Avenida Castellano, Santa Fe, New Mexico, declare and state that:

1. I received a Bachelor of Arts degree in physics from Middlebury College, Middlebury, Vermont, in 1976, and a Masters of Science and Doctorate degrees in Materials Science at the University of Wisconsin, Madison, Wisconsin, in 1977 and 1981, respectively.
2. I have been a national lab professor at the University of New Mexico in the Department of Chemical and Nuclear Engineering since March 1999.
3. I am a technical staff member at Los Alamos National Lab, Los Alamos, New Mexico, where I serve as project leader on a material aging project.
4. I am currently on a two year leave of absence from my position as a full Professor of Chemical Engineering at the Pennsylvania State University, University Park, Pennsylvania, where I have been a member of the faculty since 1982.
5. I have published over 70 peer-reviewed scientific papers, and have conducted research for over 23 years in various areas, including multimetallic catalytic chemistry and structure, catalytic etching, carbon surface chemistry, plasma physics and chemistry, materials modification by plasmas, as well as microcalorimetry and Mossbauer spectroscopy. My research is currently supported by the U.S. National Science Foundation, the U.S. Department of Energy, and individual corporations through the NSF center for Ceramic and Composite Materials co-located at the University of New Mexico and Rutgers University.
6. I was a Fulbright Fellow at the Ben Gurion University of the Negev in 1997-98.
7. Experiments were conducted to test the hypothesis that in the gas phase potassium ions will catalyze the conversion of hydrogen atoms to hydrino atoms. These experiments were initially carried out in a Calvet cell as this type of calorimeter is highly sensitive and accurate. Moreover, the conditions of the calorimeter are controlled.
8. Dr. Randell L. Mill's theory of hydrino formation requires a catalyst, such as two gaseous  $K^+$  ions, and H-atoms. In order to generate gaseous  $K^+$  ions,  $KNO_3$  was placed in a small (2cc) quartz 'boat' inside the calorimeter cell. The boat was heated, to increase the vapor concentration of  $KNO_3$ , with a platinum filament, which

was wound around the boat. A second function of the platinum filament was to generate H-atoms. It is well known that hydrogen molecules in contact with a heated filament will decompose, yielding a relatively high H-atom concentration in the boundary layer around the filament. Thus, according to Dr. Mills' model, in a cell containing  $\text{KNO}_3$  in the boat and vapor phase hydrogen, there is a small region in the boundary layer around the heated metal filament which should contain sufficient concentrations of both H-atoms and  $\text{K}^+$  ions for hydrino formation to occur.

9. Calorimetric considerations require that a stable baseline exists before the heat generating process is initiated. Thus, signal change away from the baseline can be correlated to the onset of the process under investigation. In the present experiments the cell was run with  $\text{KNO}_3$  in the boat and the filament fully 'powered'. The calorimeter was allowed to equilibrate until a steady baseline existed. The 'hydrino formation' process was initiated by then adding gaseous hydrogen.
10. In the present experiment, data was obtained which indicates that heat evolved upon the introduction of hydrogen to the Calvet calorimeter cell. In contrast, no heat was evolved upon the admission of helium. Repeated calibrations were also conducted. Thus, it appears that the Dr. Mills' hypothesis is consistent with the present results.

## EXPERIMENTAL SYSTEM

11. Calvet Calorimeter. The Calvet-type calorimeter employed in this study was similar to one described in my earlier reports to Hydrocatalysis Corporation (now BlackLight Power, Inc.), entitled "Additional Calorimetric Examples of Anomalous Heat From Physical Mixture of K/Carbon and Pd/Carbon," January 1, 1996. In essence a stainless steel cup of almost exactly  $20 \text{ cm}^3$  volume was placed in a calorimeter well such that the cup is surrounded by thermopiles on its sides and bottom. The cup and calorimeter are surrounded by a thick layer of insulation, and the entire device is placed inside a commercial convection oven. In all cases experiments were conducted with the oven temperature set to  $250^\circ\text{C}$ .
12. Reaction cell. For these experiments the top of the calorimeter cup/reactor cell was fitted with a Conflat knife edge flange. The top element of the flange is connected to a gas supply system outside the convection oven with a 0.5 cm OD ss tube, and with two welded vacuum high current copper feedthroughs. The feedthroughs were connected on the cup side of the flange to a coiled section of 0.25 mm platinum wire approximately 18 cm in length. Fitted inside the coiled platinum was a small quartz boat into which 200 mg of powdered  $\text{KNO}_3$  were placed.
13. Plumbing. On the outside of the oven the gas feed through is connected to a line

leading to hydrogen and helium tanks, a pressure gauge, and a standard vacuum roughing pump. It is notable that the gas lines were all well insulated, both inside the oven, and for about 50 cm outside the oven. The plumbing system was so arranged that the cell could be evacuated, and then isolated from the pump in such a way that hydrogen or helium could be added directly from high purity gas tanks. Great care was taken before the experiments were initiated to evacuate and flush the gas lines several times. It was also determined that the lines held gas pressure, with no loss in pressure, for several days. That is, there were no leaks.

## RESULTS

14. Calvet Calorimeter. The Calvet studies suggest large amounts of heat are generated upon the admission of hydrogen to the cell. In contrast, virtually no heat is observed upon admission of helium to the cell.
15. Calibration. The first tests performed on the Calvet system were electrical calibration experiments. The system was set-up for full experimentation:  $\text{KNO}_3$  was in the boat, the system was evacuated, and 10 watts of steady power were supplied to the platinum coil. After a steady baseline was achieved (approximately 10 hours after the oven was adjusted to  $250^\circ\text{C}$ ), the cell was isolated from the pump and the pressure allowed to equilibrate (approximately 100 Torr). This did not appear to impact the baseline in any fashion. The power supply was then adjusted to deliver an additional 1 watt (11 watt rather than 10) for a specified time period. The power was then returned to the original 10 watt setting. A typical response curve is shown in Figure 1. The area under the response curve can be used to obtain a calibration constant which relates signal area increase to the number of extra Joules delivered. This was done in four cases (Table I). As can be seen, there is some error ( $\pm 15\%$ ) in the calculated calibration constant.
16. Control Studies. Helium was admitted, approximately 10 psig, to the cell to test the impact of a change in pressure, and heat transfer characteristics on the response of the cell. The helium was admitted after the cell had been isolated from the pump for a considerable time and a steady pressure (approximately 100 Torr) achieved. As can be seen in Figure 2a, the response was a short-lived small increase in output signal, followed by a relatively short time period during which the signal gradually returns to the original baseline. Within an hour the signal returned to the original baseline, with some drift evident.
17. The response of the system was expected. The helium increased the rate of heat transfer away from the platinum filament, and heated boat. Thus, the initial addition of helium to the system resulted in a temporary increase in the amount of heat reaching the thermopiles. That is, the boat and the filament cool off; until such time as the boat and filament have reached their new steady state temperatures. The

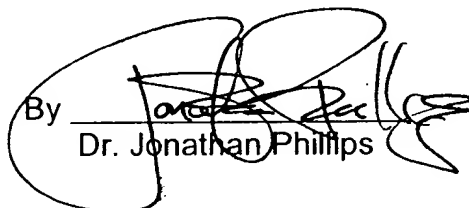
steady state temperature of the boat and filament are a function of heat transfer mechanism. After the admission of helium most heat transfer was occurring by convection to the walls. Before the admission of helium a considerable fraction was by radiation. Radiative transfer of 10 watts requires a higher filament/boat temperature than does convective heat transfer.

18. Figure 2b illustrates again the impact of adding pressure, or removing gas, from the system. Upon the addition of helium there was a very short lived increase in heat reaching the thermopiles. Upon pumping there was a period of time, perhaps an hour, during which the heat signal went below the baseline. This is consistent with the model in that pumping makes convective and diffusive heat transfer minimal. Virtually all heat transfer was by radiation, which requires that the filament/boat temperature increase. It took some time for this new steady-state temperature to be reached.
19. Hydrogen Admission. Hydrogen admission was carried out in much the same fashion as helium admission. The cell reached an equilibrium pressure, approximately 100 Torr, and then hydrogen at 10 psig was admitted to the cell. The valve to the hydrogen source, which was a steel line 4 meters by 0.6 cm OD, was closed off by a valve in front of the regulator during admission. Moreover, it was open for only a couple of seconds in each case. This was done on three separate occasions, and the signal that evolved in response to these three processes was recorded in Figures 3, 4 and 5. One other observation recorded was that the pressure decreased gradually over time, such that after about an hour the pressure returned to the original equilibrium pressure of the cell. It must also be noted that the heat production was ended deliberately in all three cases by pumping the system to  $5 \times 10^{-3}$  Torr. It is clear 'excess heat' evolution would have continued in all cases if the system had not been evacuated.
20. It was expected that in the absence of reaction that the response of the cell to the addition of hydrogen would be similar to that observed for helium. Indeed, given that pressure measurements suggest that most hydrogen was adsorbed, or in some other fashion removed from the cell after an hour, even heat transfer effects should be totally transitory. Even in the event of reaction no more than a small heat signal was expected. Indeed, a high end estimate is that  $25 \text{ cm}^3$  of hydrogen at a temperature of  $300^\circ\text{K}$  and a pressure of 2 atmospheres entered the cell. This is equivalent to  $2 \times 10^{-3}$  moles of hydrogen. If all of that hydrogen interacted with oxygen to form water only 510 J would be generated. It is possible to imagine that the hydrogen could interact with nitrogen in the  $\text{KNO}_3$  to form ammonia. However, even less energy would evolve from this process. Thus, the largest heat peak expected was 0.5 watts for 1000 seconds (approx. 17 minutes). A block of this size is marked on Figure 3.
21. It is clear from figures 3, 4 and 5 that hydrogen admission to the cell produced far

more energy evolution than can be explained by any conventional chemical process. It is interesting in this regard to graphically contrast the response of the system to helium admission to the response to that for hydrogen admission. This is done on Figure 6 in which Figure 3 and Figure 2a are superimposed.

## DISCUSSION

22. The evidence presented in this report clearly suggests that a phenomenon takes place upon the admission of hydrogen to a cell containing a heated platinum filament and  $\text{KNO}_3$ . This phenomenon appears to generate heat in excess of that expected from any known chemical process, given the content of the reactants in the cell.
23. I declare further that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

By   
Dr. Jonathan Phillips

Date: July 20, 2000

Typical Calibration Experiment: 1 W Input, 20 Mins

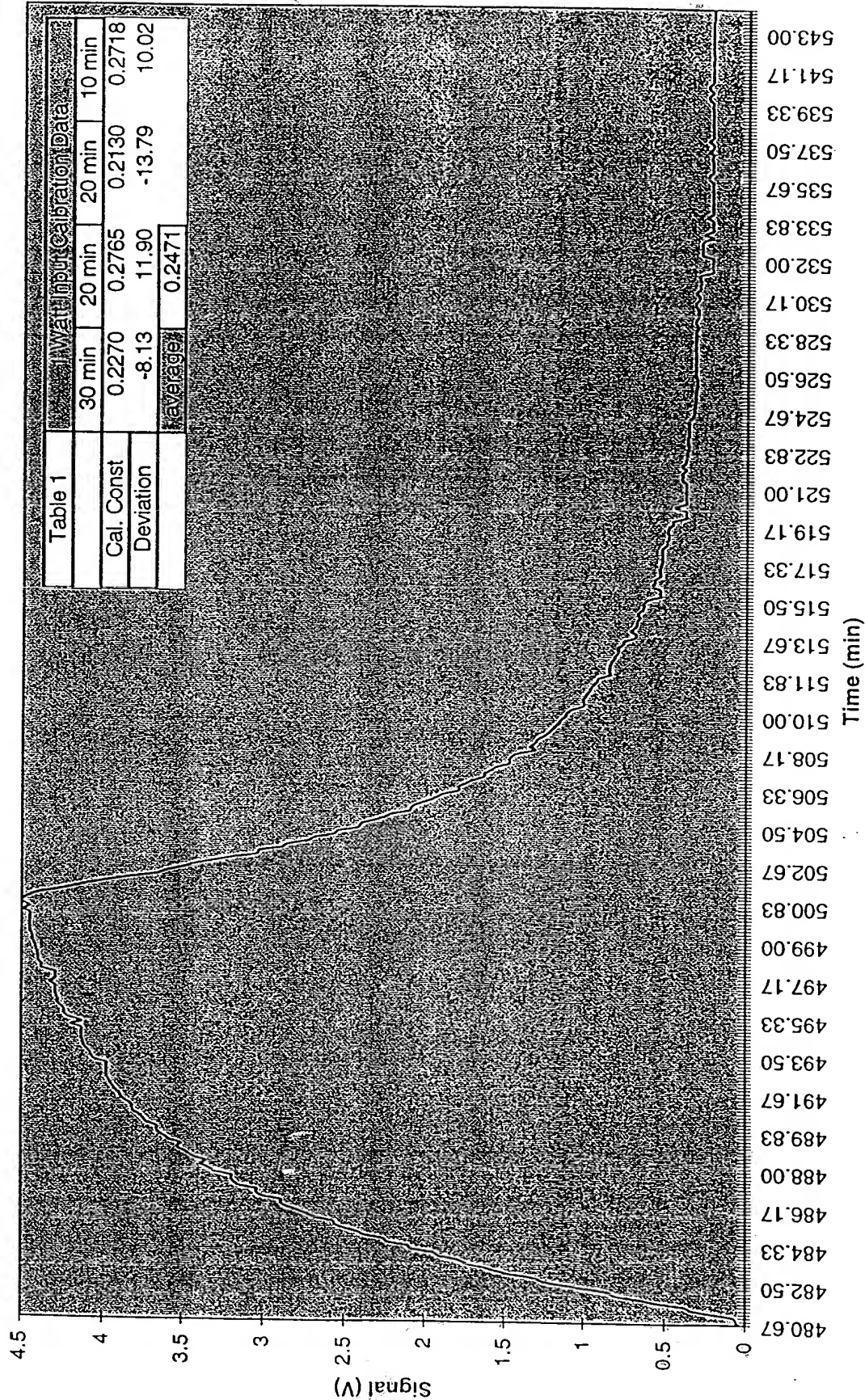


Figure 1



# Heat Production, KNO3 w/ Helium Injection (BL1220A)

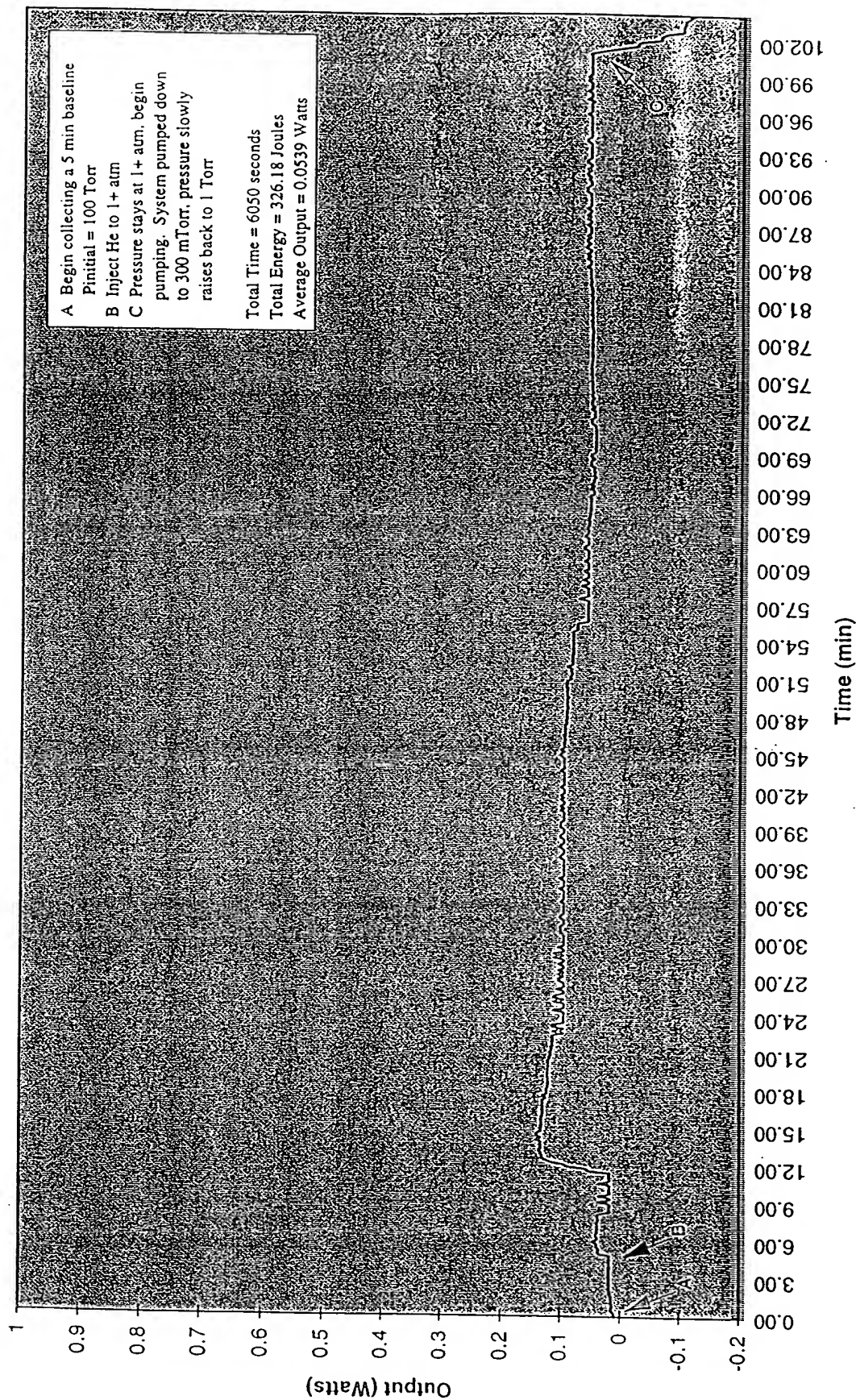


Figure 2A

# Heat Production, KNO3 w/ Helium Injection (BL1219B)

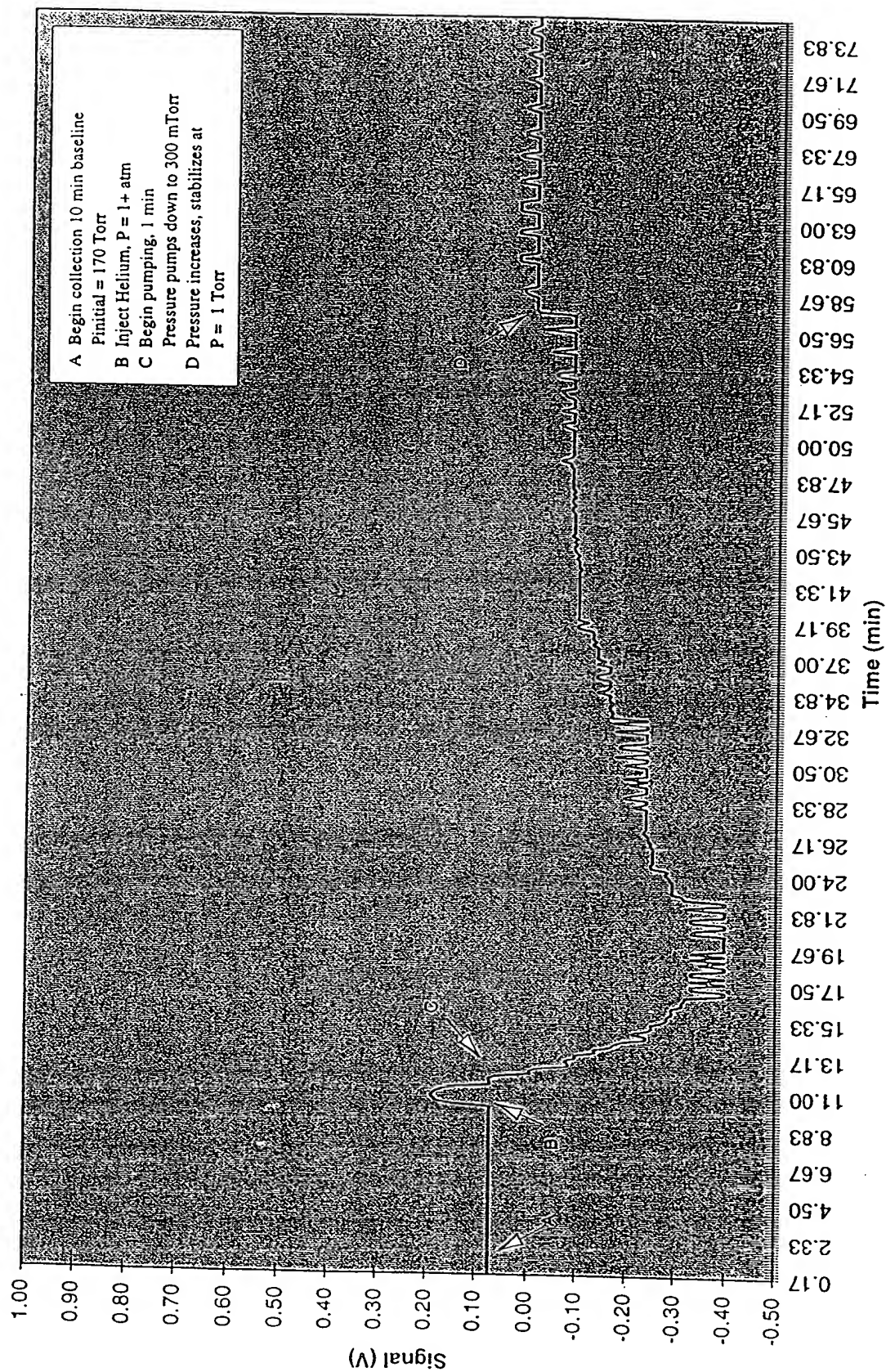
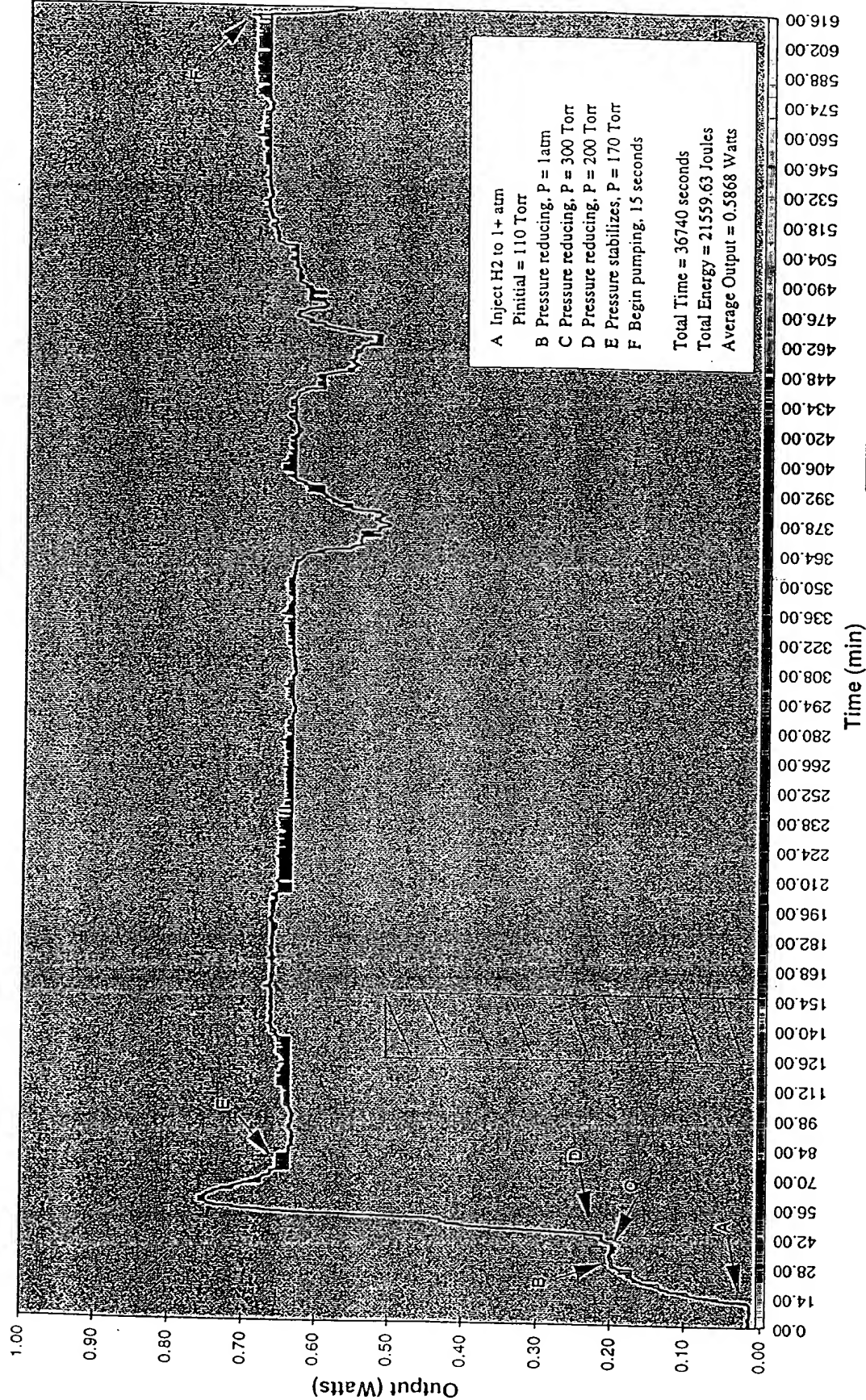


Figure 2B

# Heat Production, KNO3 w/ H2 Injection (BL1218CD)





 - Peak area expected if  
 all admitted H<sub>2</sub> reacts  
 with O<sub>2</sub> to form H<sub>2</sub>O.

Figure 3



# Heat Production, KNO3 w/ H2 Injection (BL1220BC)

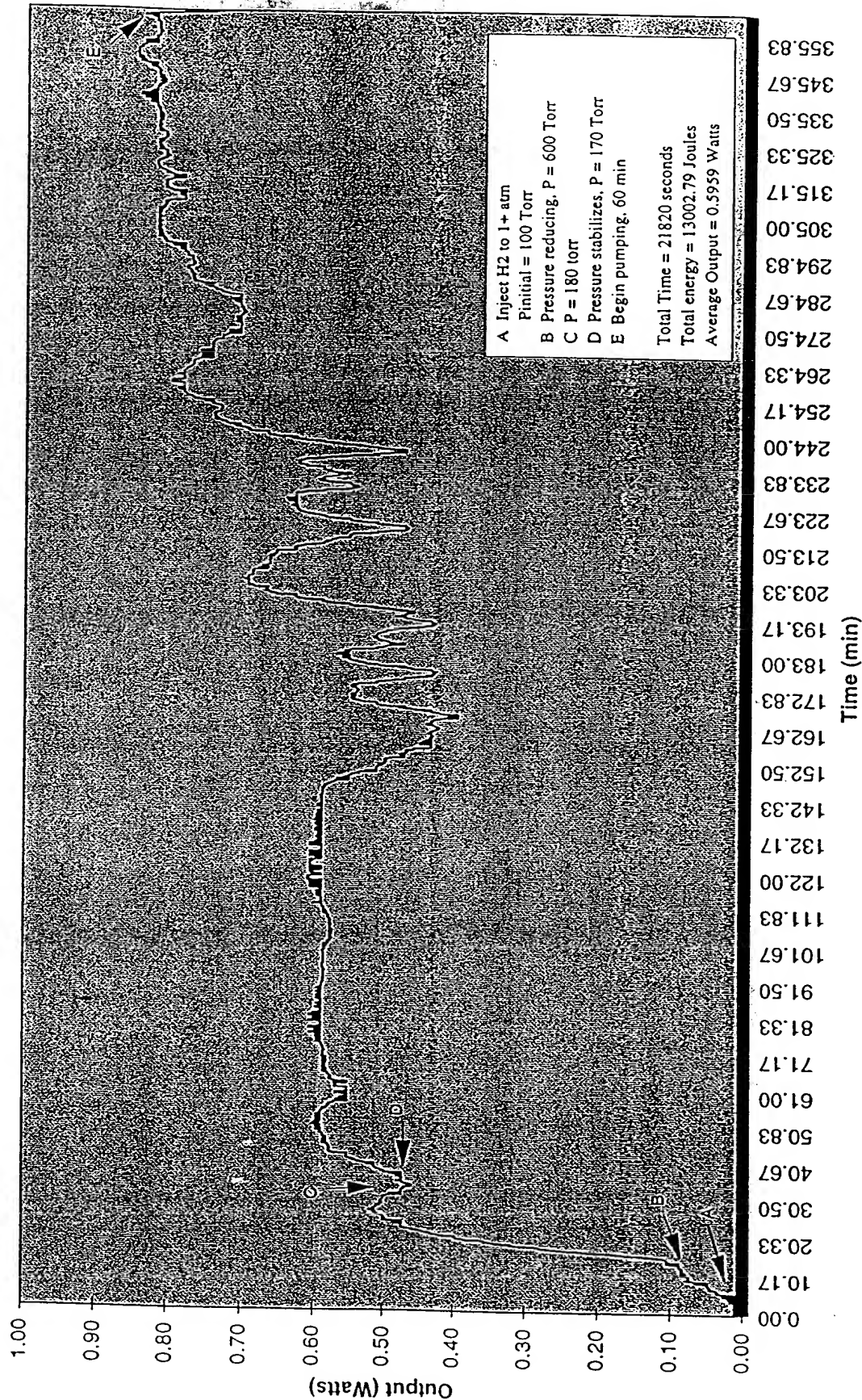


Figure 4

Heat Production, KNO3 w/ H2 Injection (BL1221AB)

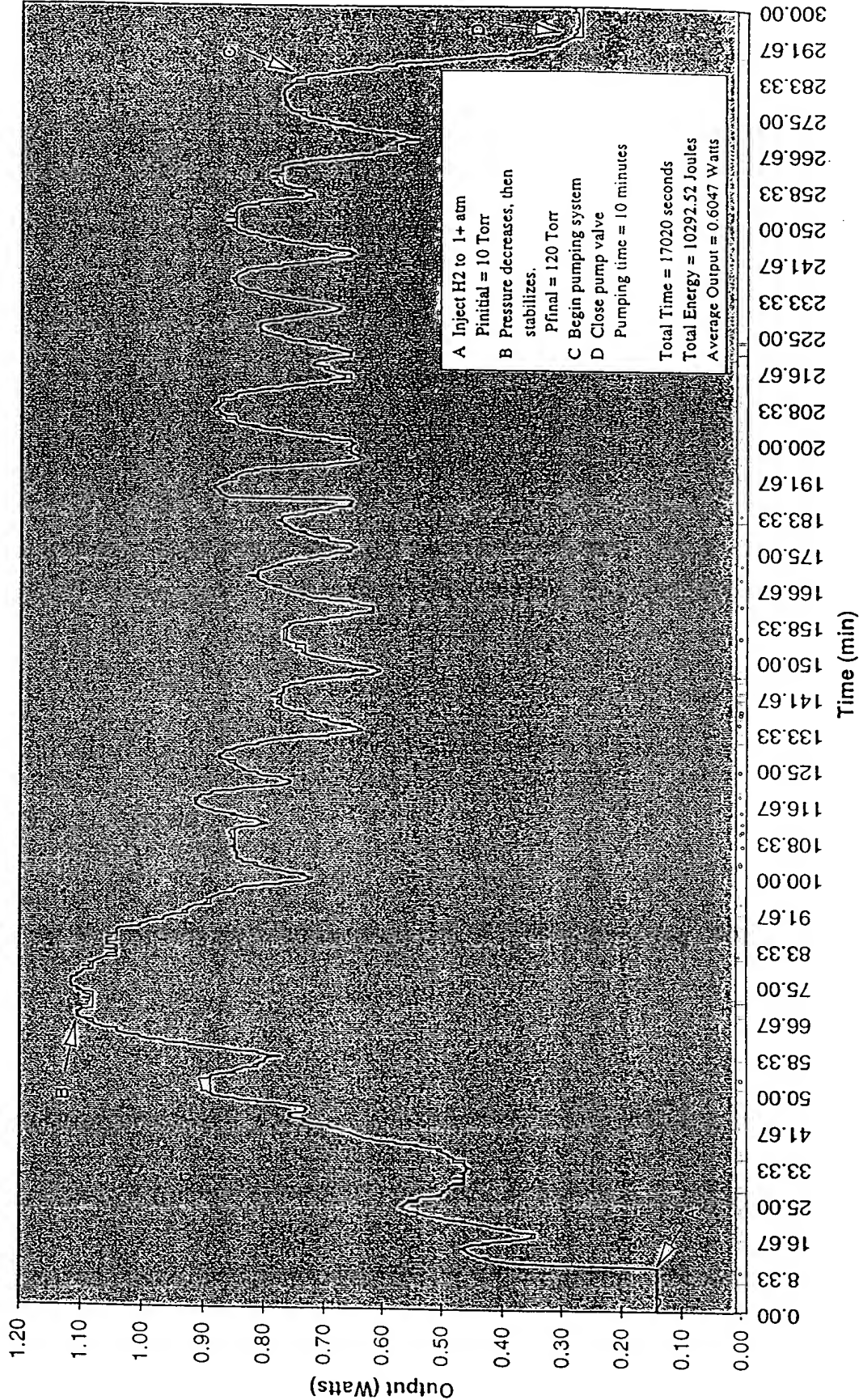


Figure 5

Heat Production, KNO3 w/ H2 and He Injection (BL1218CD,BL1219B)

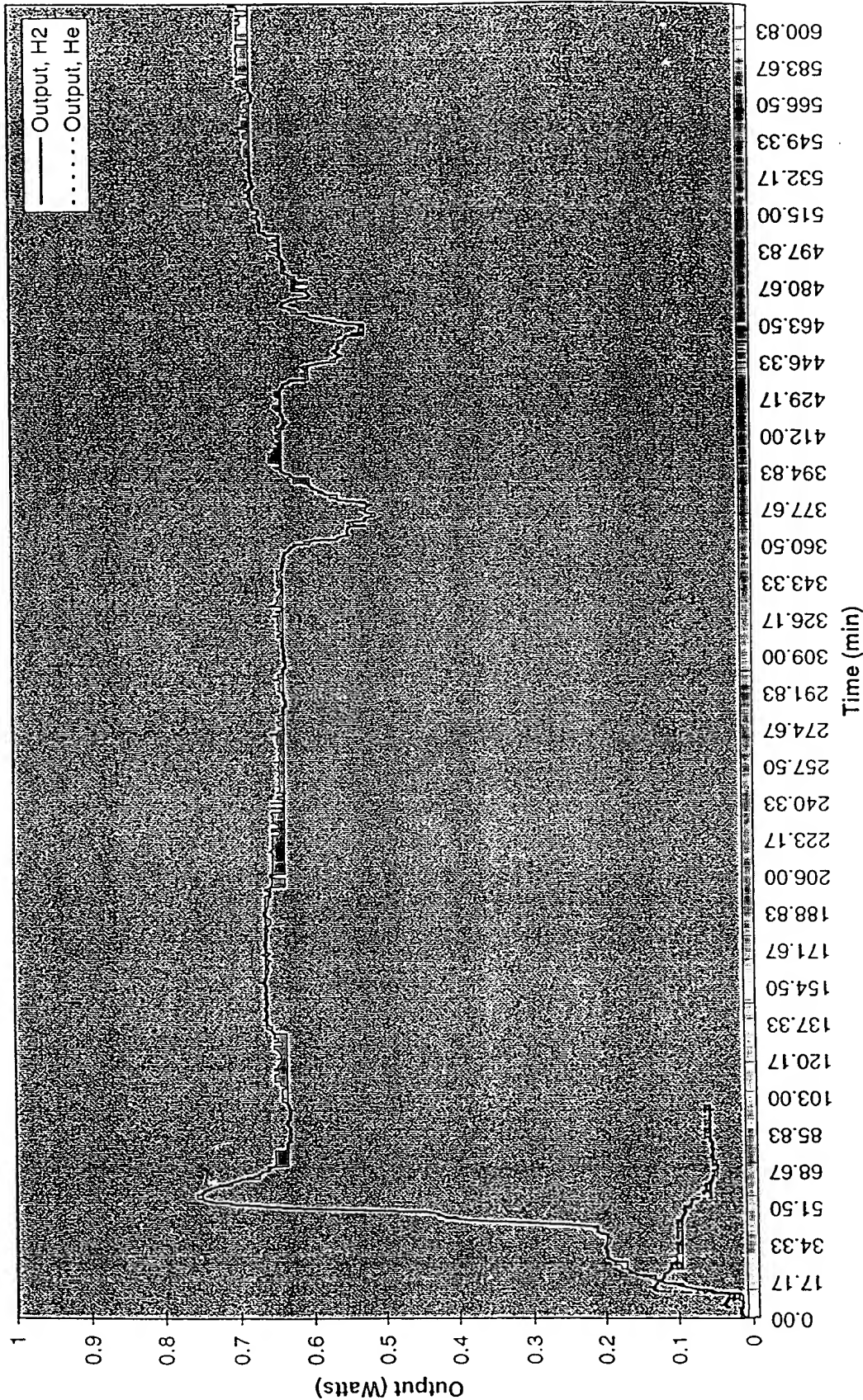


Figure 6



## **DECLARATION OF MICHAEL G. JACOX**

I, Michael G. Jacox do hereby declare and say as follows:

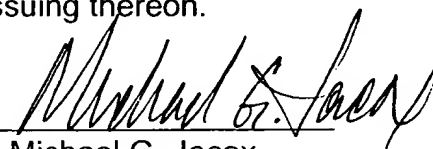
1. I received a Bachelor of Science Degree in Nuclear Engineering from the Georgia Institute of Technology in 1985. I received a Masters of Science Degree in Nuclear Engineering from the University of Idaho in 1992.
2. From 1998 to the present, I have been employed as an Assistant Director for the Commercial Space Center for Engineering (CSCE), Texas A & M University, where I have developed a strategic plan for a newly created NASA commercial space center which resulted in an increase of NASA funding from \$500K to \$1M annually. I planned and executed the campaign for industry input and support of the CSCE. I led the development of the first integrated payload design center at Texas A & M University.
3. From 1996-1998, I was employed as a Program Manager at the Space Dynamics Lab, Utah State University, where I defined, promoted and managed the \$50M Solar Orbit Transfer Vehicle (SOTV) space experiment and technology development program. I also completed the first ever system-level ground test of the Integrated Solar Upper State (ISUS) on time and within the \$15M budget.
4. From 1994-1996, I was employed as a Systems Engineer at Lockheed-Martin Idaho Technologies, where I managed a team of more than 30 engineers and scientists from NASA, the Naval Research Lab, Air Force Research Lab and industry in a highly successful \$1M system definition study of the ISUS space power and propulsion concept. I also managed a joint DOD-DOE nuclear bimodal systems engineering team that evaluated concepts and developed preliminary designs of combined power and propulsion reactors.
5. From 1989-1994, I was employed as a Senior Scientist at EG&G Idaho, where I conceived the design and managed the development and testing of the first integrated thermionic/heat-pipe module for nuclear bimodal applications. The multi-million dollar effort resulted in successful prototype testing. I also managed the design and installation of a unique multi-million dollar hot hydrogen test facility at the Idaho National Engineering Lab. I further originated the design of the Small-Ex-core Heat Pipe Thermionic Reactor (SEHPTR), led the SEHPTR conceptual design team, and received a patent covering the SEHPTR. I also developed and benchmarked the first three-dimensional neutronics model of the Advanced Test Reactor.
6. From 1985-1989, I was employed as a Nuclear Research Officer at USAF Weapons Lab, where I led the Air Force's space nuclear power application studies resulting in significant national program modifications and the development of the Military Space Reactor Initiatives. I also installed advanced nuclear reactor analysis codes on in-house computers.

7. While employed at EG&G, I contracted for the Idaho National Engineering Laboratory (INEL) under a DOE contract. At INEL, I conducted three experiments in which hydrogen was reacted with a catalyst, (K<sup>+</sup>, K<sup>+</sup>), generated from aqueous K<sub>2</sub>CO<sub>3</sub>, in an electrolytic cell containing nickel and platinum electrodes. The test conditions and results are shown in the attached report. As can be seen from the test results, 20 to 30 watts of excess heat was observed and in one instance the ratio of excess power to input electrolysis joule heating power was 850%.

8. The evidence presented in the attached report clearly demonstrates that a phenomenon takes place upon the admission of hydrogen to an electrolytic cell containing aqueous KCO<sub>3</sub>. This phenomenon generates heat in excess of that expected from any known chemical process, given the content of the reactants in the cell. A detailed analysis of all constituents was conducted to ensure that no chemical reactions were occurring which could be generating the excess heat observed.

9. I declare further that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

By



Michael G. Jacox

Date:

25 July 00



## Experimental Verification by Idaho National Engineering Laboratory

### Methods

A search for excess heat during the electrolysis of aqueous potassium carbonate ( $K^+/K^+$  electrocatalytic couple) was investigated using cells supplied by HydroCatalysis Power Corporation and a cell fabricated by Idaho National Engineering Laboratory (INEL). To simplify the calibration of these cells, they were constructed to have primarily conductive and forced convective heat losses. Thus, a linear calibration curve was obtained. Differential calorimetry was used to determine the cell constant which, was used to calculate the excess enthalpy. The cell constant was calculated during the experiment (on-the-fly-calibration) by turning an internal resistance heater off and on, and inferring the cell constant from the difference between the losses with and without the heater.

The general form of the energy balance equation for the cell in steady state is:

$$0 = P_{\text{appl}} + Q_{\text{htr}} + Q_{\text{xs}} - P_{\text{gas}} - Q_{\text{loss}} \quad (\text{III.1})$$

where  $P_{\text{appl}}$  is the electrolysis power;  $Q_{\text{htr}}$  is the power input to the heater;  $Q_{\text{xs}}$  is the excess heat power generated by the hydrogen "shrinkage" process;  $P_{\text{gas}}$  is the power removed as a result of evolution of  $H_2$  and  $O_2$  gases; and  $Q_{\text{loss}}$  is the thermal power loss from the cell. When an aqueous solution is electrolyzed to liberate hydrogen and oxygen gasses, the electrolysis power  $P_{\text{appl}} (=E_{\text{appl}}I)$  can be partitioned into two terms:

$$P_{\text{appl}} = E_{\text{appl}}I = P_{\text{cell}} + P_{\text{gas}} \quad (\text{III.2})$$

An expression for  $P_{\text{gas}} (=E_{\text{gas}}I)$  is readily obtained from the known enthalpy of formation of water from its elements:

$$E_{\text{gas}} = \frac{-\Delta H_{\text{form}}}{\alpha F} \quad (\text{III.3})$$

( $F$  is Faraday's constant), which yields  $E_{\text{gas}} = 1.48 \text{ V}$  for the reaction



The net faradaic efficiency of gas evolution is assumed to be unity; thus, Eq. (III.2) becomes

$$P_{\text{cell}} = (E_{\text{appl}} - 1.48V)I \quad (\text{III.5})$$

The cell was calibrated for heat losses by turning an internal resistance heater off and on while maintaining constant electrolysis and by inferring

the cell constant from the difference between the losses with and without the heater where heat losses were primarily conductive and forced convective losses. When the heater was off, the losses were given by

$$c(T_C - T_b) = P_{\text{appl}} + 0 + Q_{\text{xs}} - P_{\text{gas}} \quad (\text{III.6})$$

where  $c$  is the heat loss coefficient;  $T_b$  is ambient temperature and  $T_C$  is the cell temperature. When a new steady state is established with the heater on, the losses change to:

$$c(T_C' - T_b) = P_{\text{appl}}' + Q_{\text{htr}} + Q_{\text{xs}}' - P_{\text{gas}}' \quad (\text{III.7})$$

where a prime superscript indicates a changed value when the heater was on. When the following assumptions apply

$$Q_{\text{xs}} = Q_{\text{xs}}'; P_{\text{appl}} = P_{\text{appl}}'; P_{\text{gas}} = P_{\text{gas}}' \quad (\text{III.8})$$

the cell constant or heating coefficient  $a$ , the reciprocal of the heat loss coefficient( $c$ ), is given by the result

$$a = \frac{T_C' - T_C}{Q_{\text{htr}}} \quad (\text{III.9})$$

In all heater power calculations, the following equation was used

$$Q_{\text{htr}} = E_{\text{htr}} I_{\text{htr}} \quad (\text{III.10})$$

## LIGHT WATER CALORIMETRY EXPERIMENTS

### INEL EXPERIMENT 1 (DC Operation)

The present experiments were carried out by observing and comparing the temperature difference,  $\Delta T_1 = T(\text{electrolysis only}) - T(\text{blank})$  and  $\Delta T_2 = T(\text{electrolysis plus resistor heating}) - T(\text{blank})$  referred to unit input power.

The cell comprised a 10 gallon (33 in. x 15 in.) Nalgene tank (Model # 54100-0010). Two 4 inch long by 1/2 inch diameter terminal bolts were secured in the lid, and a cord for a heater was inserted through the lid.

The cathode comprised 1.) a 5 gallon polyethylene bucket which served as a perforated (mesh) support structure where 0.5 inch holes were drilled over all surfaces at 0.75 inch spacings of the hole centers and 2.) 5000 meters of 0.5 mm diameter clean, cold drawn nickel wire (NI 200 0.0197", HTN36NOAG1, AI Wire Tech, Inc.). The wire was wound uniformly around the outside of the mesh support as 150 sections of 33 meter length. The ends of each of the 150 sections were spun to form three cables of 50 sections per cable. The cables were pressed in a terminal connector which was bolted to the cathode terminal post. The connection was covered with epoxy to prevent corrosion.

The anode comprised an array of 15 platinized titanium anodes (15 - Engelhard Pt/Ti mesh 1.6" x 8" with one 3/4" by 7" stem attached to the 1.6" side plated with 100 U series 3000). A 3/4" wide tab was made at the end of the stem of each anode by bending it at a right angle to the anode. A 1/4" hole was drilled in the center of each tab. The tabs were bolted to a 12.25" diameter polyethylene disk (Rubbermaid Model #2666) equidistantly around the circumference. Thus, an array was fabricated having the 15 anodes suspended from the disk. The anodes were bolted with 1/4" polyethylene bolts. Sandwiched between each anode tab and the disk was a flattened nickel cylinder also bolted to the tab and the disk. The cylinder was made from a 7.5 cm by 9 cm long x 0.125 mm thick nickel foil. The cylinder traversed the disk and the other end of each was pressed about a 10 A /600 V copper wire. The connection was sealed with

Teflon tubing and epoxy. The wires were pressed into two terminal connectors and bolted to the anode terminal. The connection was covered with epoxy to prevent corrosion.

Before assembly, the anode array was cleaned in 3 M HCl for 5 minutes and rinsed with distilled water. The cathode was cleaned in 3% H<sub>2</sub>O<sub>2</sub>/ 0.57 M K<sub>2</sub>CO<sub>3</sub> and rinsed with distilled water. The anode was placed in the cathode support and the electrode assembly was placed in the tank containing electrolyte. The power supply was connected to the terminals with large cables.

The electrolyte solution comprised 28 liters of 0.57 M K<sub>2</sub>CO<sub>3</sub> (Alfa K<sub>2</sub>CO<sub>3</sub> 99%) in the case of the MC 3 cell or 28 liters of 0.57 M Na<sub>2</sub>CO<sub>3</sub> (Alfa Na<sub>2</sub>CO<sub>3</sub> 99%) in the case of the MC 2 cell.

The heater comprised a 57 ohm 1500 watt Incoloy coated cartridge heater which was suspended from the polyethylene disk of the anode array. It was powered by a regulated power supply. The voltage was measured with a digital meter, and the current was measured as a voltage across a precision resistor with a digital meter.

The stirrer comprised a 1 cm diameter by 43 cm long glass rod to which an 8 cm by 2.5 cm Teflon half moon paddle was fastened at one end. The rod passed through a bearing hole in the tank lid and through a bearing hole in the center of the anode array disk. The other end of the stirrer rod was connected to a variable speed stirring motor. The stirrer shaft was rotated at 4 Hz. With the stirrer connected, the stirrer motor drew 4.7 W. With the stirrer disconnected, the stirrer drew 4.4 W; thus, 0.3 W was the stirrer power.

Electrolysis was performed at 39.5 amps constant current with a constant current power supply. The cells were operated in the environmental chamber in the INEL Battery test Laboratory. The chamber maintained the average temperature of the cell surroundings within 1 °C. The bottom of the cell rested on a 1/2 inch thick sheet of Styrofoam.

The temperature was recorded with a series of Teflon-coated Type E thermocouples inserted in several places. The ambient temperature reference was a closed one-liter container of water

with a thermocouple nominally in the center of the water volume.

Data from thermocouples, voltages, and currents were logged by one of the Battery Lab's computer based data systems and recorded at 5 minute intervals. The delta temperature ( $\Delta T = T(\text{electrolysis only}) - T(\text{blank})$ ) and electrolysis power were plotted. The heating coefficient was determined "on the fly" by the addition of heater power. The delta temperature  $\Delta T_2 = T(\text{electrolysis} + \text{heater}) - T(\text{blank})$  and the electrolysis power and heater power were plotted.

Mass spectroscopy of the gasses evolving from the MC 3 ( $\text{K}_2\text{CO}_3$ ) cell was performed using a VG Instruments model SXP-50 high -precision mass spectrometer with 0.01-amu mass resolution and 6 decade sensitivity.

A 100 ml sample of the 0.57 M  $\text{K}_2\text{CO}_3$  electrolyte of the MC 3 ( $\text{K}_2\text{CO}_3$ ) cell was removed after 20 days of cell operation, and a chemical analysis was performed on the electrolyte using an Inductively Coupled Plasma-Atomic Emission Spectrometer.

## RESULTS

### Light Water Calorimetry

The results of the electrolysis for INEL cell runs MC 2 and MC 3 at 39.5 A constant current appear in Figure 1 (hand plot of data by INEL scientists). As shown in Figure 1, the MC 3 ( $\text{K}_2\text{CO}_3$ ) cell intercepts the Total Input Power axis at 35 W; whereas, the MC 2 ( $\text{Na}_2\text{CO}_3$ ) cell intercepts the Total Input Power axis at 59 W. The input power to electrolysis gases given by Eqs. (III.2-III.5) is  $(39.5)(1.48) = 58.5$  W. The production of excess enthalpy of 25 W is observed with the MC 3 ( $\text{K}_2\text{CO}_3$ ) cell, and energy balance is observed with the MC 2 ( $\text{Na}_2\text{CO}_3$ ) cell.

Mass spectroscopic analysis of the gasses evolved by the MC 3 ( $\text{K}_2\text{CO}_3$ ) cell showed that a significant fraction of the sample was air with standard constituents. When the spectrum associated with air was removed, the residue showed a majority of diatomic hydrogen and oxygen gases in approximately the 2:1 proportion expected from the electrolysis and residual water vapor. There were no hydrocarbons, no metallic constituents or other anomalies except that a slightly higher than expected hydrogen to oxygen ratio was observed. No

tritium or deuterium measurements above normal background were observed.

Chemical analysis of an electrolyte sample from the MC 3 ( $K_2CO_3$ ) cell after 20 days of operation found the following components at levels above the background levels in the water used to fill and replenish the cell: 1.7 ppm silicon, 1.1 ppm sulfur, and 46.5 ppm sodium in addition to the  $K_2CO_3$  salt. Small quantities of silicon are known impurities in the nickel wire and may have also come from the glassware used in various processes. Sulfur is a common impurity in the salt, and it may have come from the resin beds used for water deionization. Sodium is a probable salt impurity, and it may also have come from hand contact with the system. The potassium was measured at 43,000  $\mu g/ml$  corresponding to a salt molarity of 0.55 M (within measurement error of the initial 0.57 molarity determined by weighing the salt and measuring the water for the initial charge). The electrolyte retained its molarity. The cell potential characteristics were essentially unchanged over the duration of operation. There were no nickel or other metallic compounds present in the electrolyte. A visual inspection of the cell showed that all of the structural components were intact. The cell comprised about 155 moles of nickel in the cathode, about 6.5 moles of titanium in the anodes, and about 13.7 moles of  $K_2CO_3$ . The only material consumed in the cell was nano-pure deionized water.

## **INEL EXPERIMENT II (Pulsed Power Operation)**

The MC 3 ( $K_2CO_3$ ) cell was wrapped in a one-inch layer of urethane foam insulation about the cylindrical surface. The top was not insulated. The bottom of the cell rested on a 1/2 inch thick sheet of Styrofoam.

The cell was operated in a pulsed power mode. A current of 10 amperes was passed through the cell for 0.2 seconds followed by 0.8 seconds of zero current for the current cycle. The cell voltage was about 2.4 volts, for an average input power of 4.8 W. The electrolysis power average (Eq. (III.5)) was 1.84 W, and the stirrer power was measured to be 0.3 W. Thus, the total average net input power was 2.14 W. The cell was operated at various resistance heater settings, and the temperature

difference between the cell and the ambient as well as the heater power were measured.

## RESULTS

### Light Water Calorimetry

The results of the excess power as a function of cell temperature with the MC 3 cell operating in the pulsed power mode at 1 Hz with a cell voltage of 2.4 volts, a peak current of 10 amperes, and a duty cycle of 20 % appears in Figure 2.

Figure 2 shows that the excess power is temperature dependent for pulsed power operation, and the maximum excess power shown in Figure 2 is 18 W for an input electrolysis joule heating power of 2.14 W. Thus, the ratio of excess power to input electrolysis joule heating power is 850 %.

### INEL EXPERIMENT III (Forced Convection Calorimetry Of INEL Cell)

INEL scientists constructed an electrolytic cell comprising a nickel cathode, a platinized titanium anode, and a 0.57 M  $K_2CO_3$  electrolyte. The cell design appears in Appendix 1. The cell was operated in the environmental chamber in the INEL Battery test Laboratory at constant current, and the heat was removed by forced air convection in two cases. In the first case, the air was circulated by the environmental chamber circulatory system alone. In the second case, an additional forced air fan was directed onto the cell.

The cell was equipped with a water condensor, and the water addition to the cell due to electrolysis losses was measured.

## RESULTS

### Light Water Calorimetry

The data of the forced convection heat loss calorimetry experiments during the electrolysis of a 0.57 M  $K_2CO_3$  electrolyte with the cell appears in Table 1 and Figure 3. The comparison of the calculated and measure water balance of the INEL cell appears in Table 2 and Figure 4.

The intercept of the Net Input Power (calculated using Eq. (III.5)) axis of Figure 3 for both cases of forced convection is 13 W. Thus, 13 W of excess power was produced by the INEL cell. This excess power can not be attributed to recombination of the hydrogen and oxygen as indicated by the

equivalence of the calculated and measured water balance as shown in Figure 4.



Figure 1.

# THERMAL CONDUCTANCE CALIBRATION (11/25)

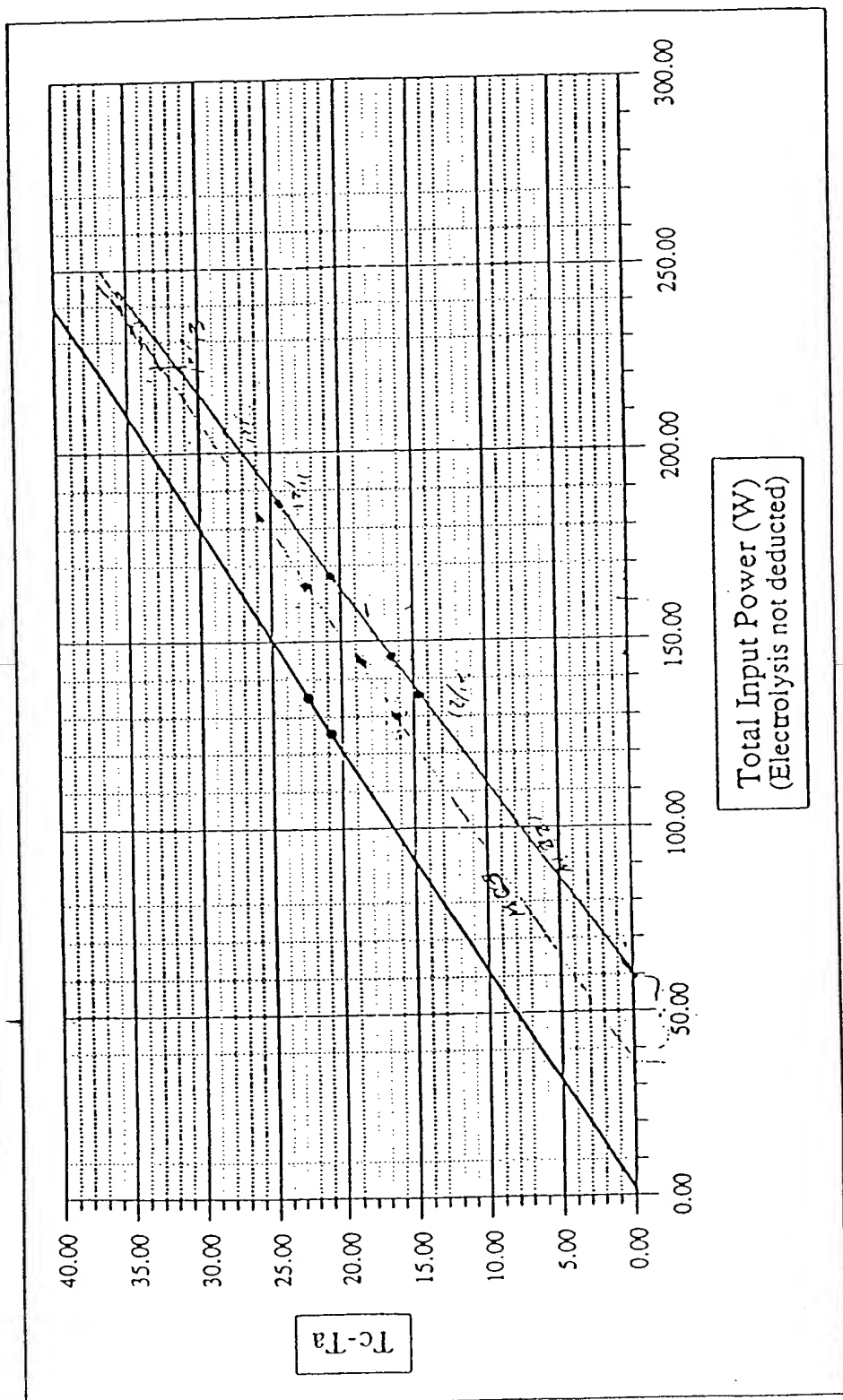


Figure 2.

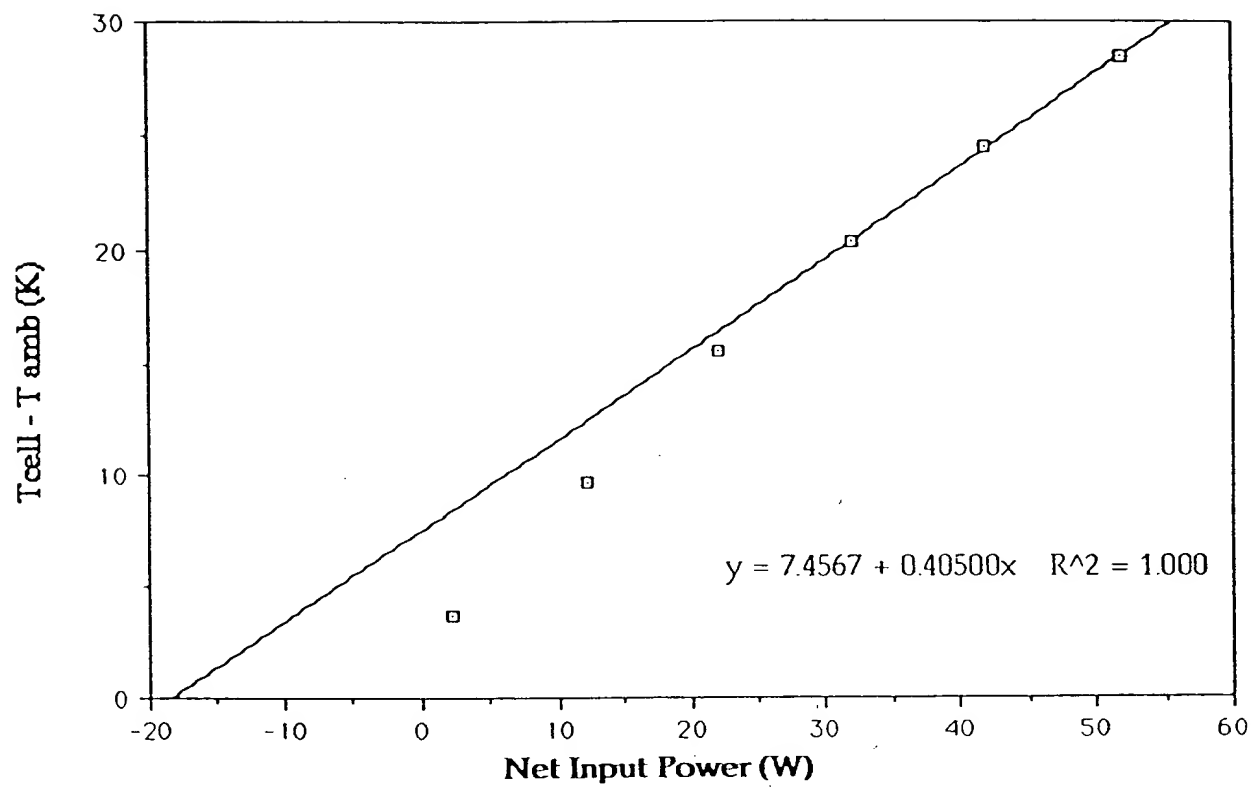
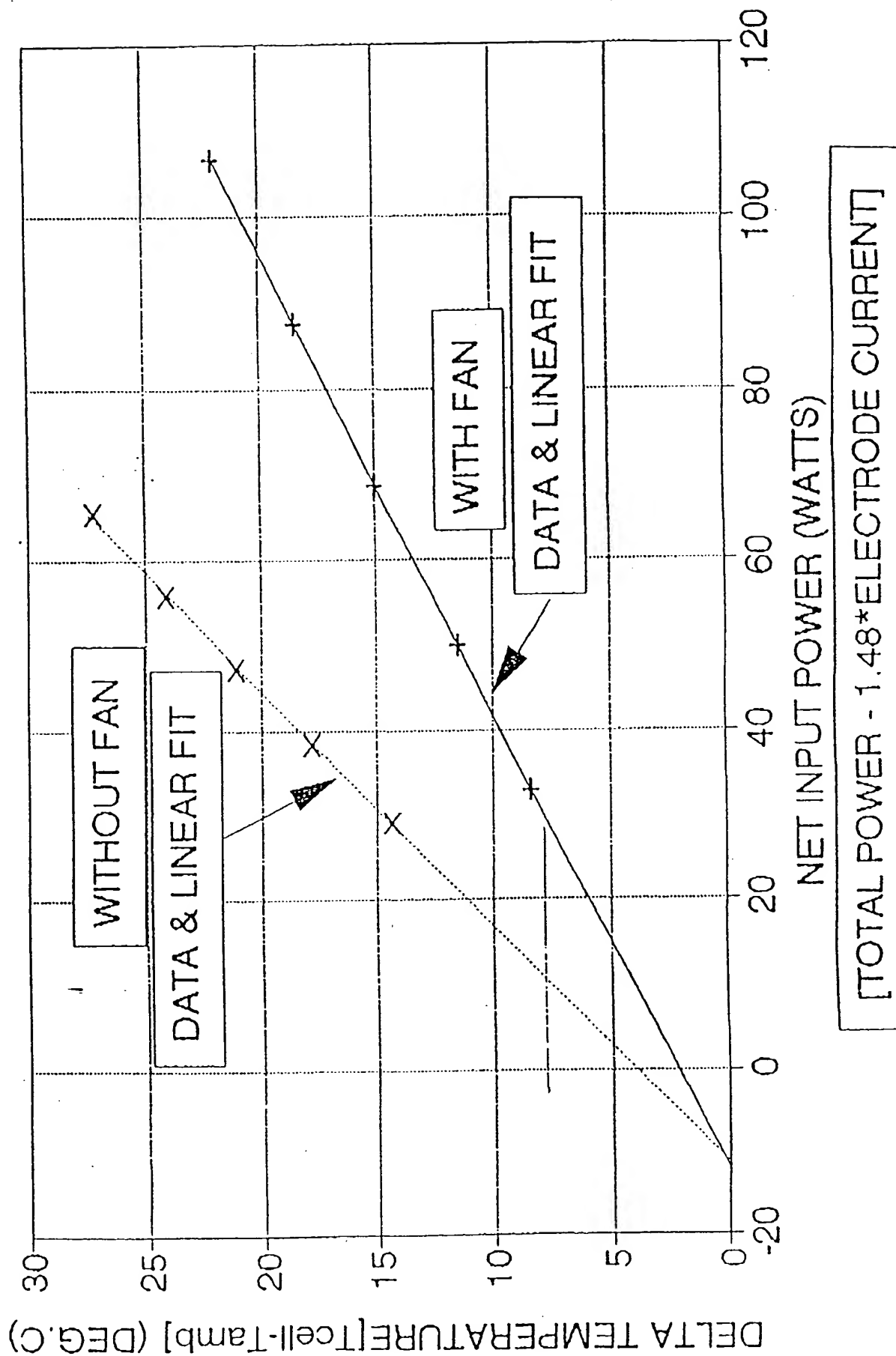


Figure 3.

# IC1

T99 THRU T103 & T105 THRU T109



# IC1 WATER ADDITION

1/9/93 THRU 1/29/93

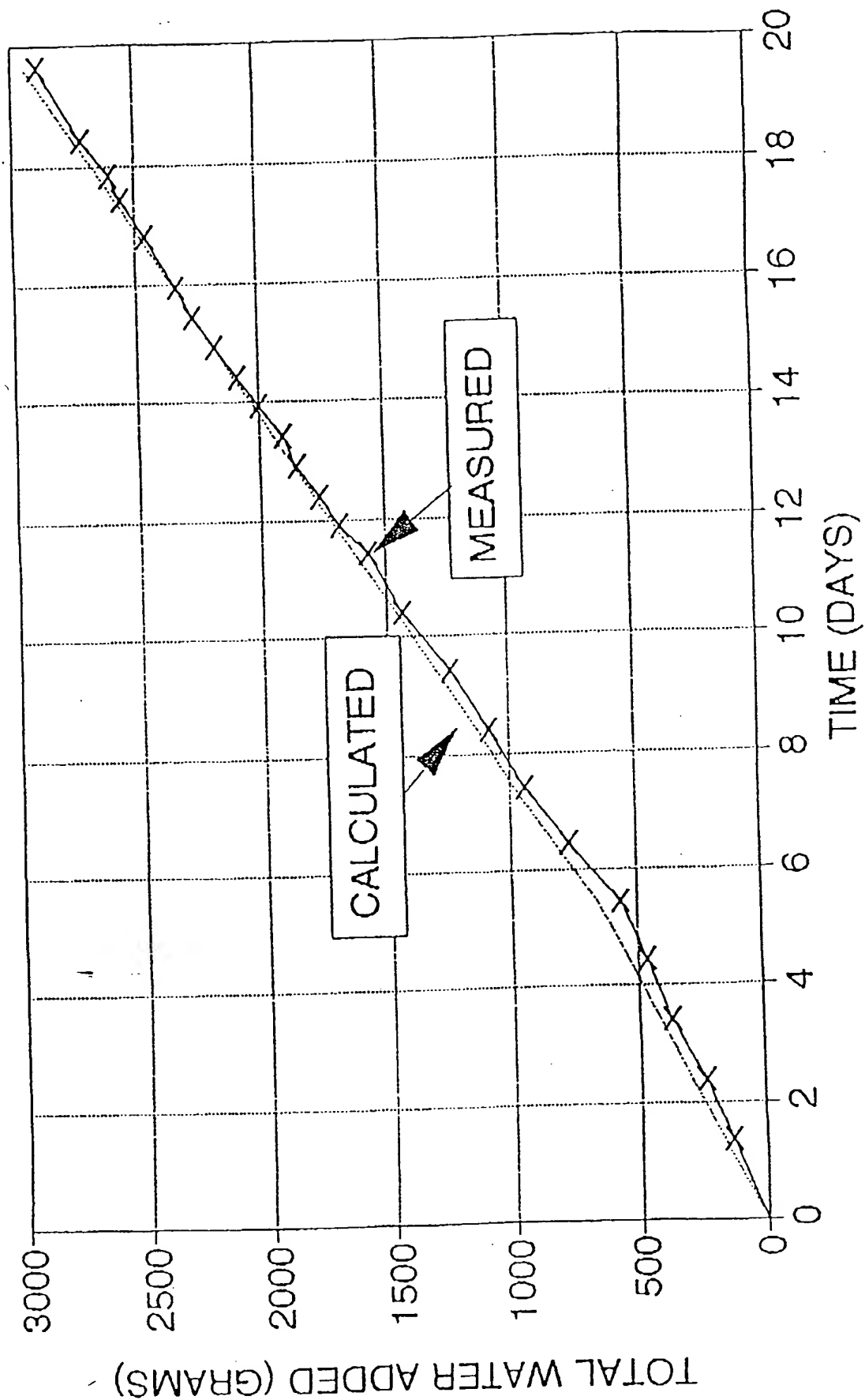


Table 1.  
FILE IC1

TEST NO.	TOTAL POWER	DELTA TEMP	LF DT	DELTA TEMP	LF DT	PWR-A*1.48
T09	94.8	27.2	27.36265			65.2962
T100	85.2	24.05	23.93155			55.6962
T101	76.8	21.05	20.92933			47.2962
T102	87.8	17.75	17.71267			38.2962
T103	58.57	14.3	14.4138			29.0662
	18.24		-0.00042			-11.2638
T105	136.07			21.95	21.94573	106.6662
T106	117.05			18.42	18.42674	87.5462
T107	98.25			14.95	14.94844	68.7462
T108	79.45			11.47	11.47015	49.9462
T109	62.58			8.35	8.348937	33.0762
	17.45				-0.00082	-12.0538

Table 2.  
ICI WATER ADDITION ; FILE ICI WATER

DATE	TIME			QPRO TIME	QPRO DATE+TIM	DATE-START DAYS	ELECTRO AMP8	WATER GRAM8	WATER TOTAL	WATER CALO	TOTAL CALC	ADDED/CALC
	HOURS	MINUTES	SECONDS									
01/09/93	21	30	0	0.885833	33978.9	-0.00416687	16	0	0	0	0	
01/11/93	7	15	0	0.302063	33980.3	1.402083333	15	131	131	169.9935	169.9935	0.77081781
01/12/93	7	10	0	0.298811	33981.3	2.368611111	16	108	239	120.4645	290.468	0.82983844
01/13/93	7	20	0	0.311806	33982.31	3.411806556	14.94	131	370	121.9593	412.4473	0.89708429
01/14/93	7	55	0	0.330556	33983.33	4.430556556	14.94	89	469	122.8582	538.1088	0.8577747
01/15/93	7	50	0	0.329389	33984.33	5.429388889	14.93	102	561	118.8188	654.9243	0.8588875
01/16/93	8	20	0	0.351369	33985.33	6.461388889	18.93	205	766	184.8302	810.6648	0.83463404
01/17/93	8	19	0	0.346828	33986.36	7.446827778	19.93	168	934	169.8341	978.3887	0.9536851
01/18/93	7	42	0	0.320833	33987.32	8.420833333	19.94	160	1084	158.6885	1135.935	0.98428201
01/19/93	7	32	0	0.313688	33989.31	9.413688889	19.93	164	1238	158.4995	1293.488	0.96884903
01/20/93	7	25	0	0.309028	33989.31	10.40902778	19.94	194	1432	159.9143	1466.389	0.98394292
01/21/93	7	42	0	0.320833	33990.32	11.42083333	19.93	133	1666	182.511	1817.88	0.98731828
01/21/93	19	28	0	0.811111	33990.81	11.91111111	19.93	110.5	1875.5	78.7489	1896.628	0.85754898
01/22/93	7	32	0	0.313889	33991.31	12.41388889	19.93	83	1768.6	80.76369	1777.379	0.98937791
01/22/93	19	37	0	0.817361	33991.82	12.91736111	19.93	82	1850.6	80.88513	1858.249	0.6968323
01/23/93	7	32	0	0.313889	33992.31	13.41388889	19.94	48	1898.5	79.78976	1938.034	0.97858882
01/23/93	19	19	0	0.804861	33992.8	13.90486111	19.93	102	1998.8	78.86744	2018.892	0.98088111
01/24/93	7	28	0	0.311111	33993.31	14.41111111	19.93	84	2082.5	81.31128	2098.203	0.99281693
01/24/93	19	20	0	0.805556	33993.81	14.90888889	19.93	93	2175.8	79.41813	2177.818	0.98902727
01/26/93	7	38	0	0.318035	33994.32	15.4180556	19.93	94	2269.6	82.31512	2259.933	1.00423318
01/25/93	20	1	0	0.834028	33994.83	15.93402778	19.93	86	2334.5	82.87281	2342.806	0.99846461
01/26/93	16	31	0	0.888184	33995.89	16.78818444	18.93	122	2458.5	137.1919	2478.998	0.98052498
01/27/93	7	46	0	0.322917	33996.32	17.42291687	19.93	98	2552.5	101.9468	2681.944	0.98859824
01/27/93	17	35	0	0.732839	33996.73	17.83283889	19.94	59	2608.8	86.8408	2847.784	0.98518331
01/28/93	7	47	0	0.324306	33997.32	18.42430556	19.93	107	2715.6	85.03047	2742.815	0.99004131
01/29/93	12	50	0	0.634722	33998.53	19.63472222	19.94	171	2888.5	194.5085	2937.323	0.98289741

Appendix I.

DATE: December 15, 1992  
TO: Richard Deaton MS 4139, Ext. 6-2016, FAX 6-2681  
FROM: R. L. Drexler MS 3123, Ext. 6-1789  
SUBJECT: INEL CELL CATHODE ESTIMATE

Attached are the following sketches and revised sketches:

Cathode Assembly for INEL CELL	12/15/92
Narrow Cathode Strap for INEL CELL	12/15/92
Cathode C-1 INEL CELL	12/2/92
Mandrel - Cathode Winding	12/8/92
Electrode Bus Ring INEL CELL	12/15/92

Would you please give us a firm estimate for fabrication of two "identical" cathode assemblies per the 12/15/92 sketch, and two Electrode Bus Rings per the 12/15/92 sketch.

The cathode windings could be made on a mandrel per the sketch 12/8/92 or similar suitable arrangement.

These cathodes and bus rings are similar to those previously fabricated except:

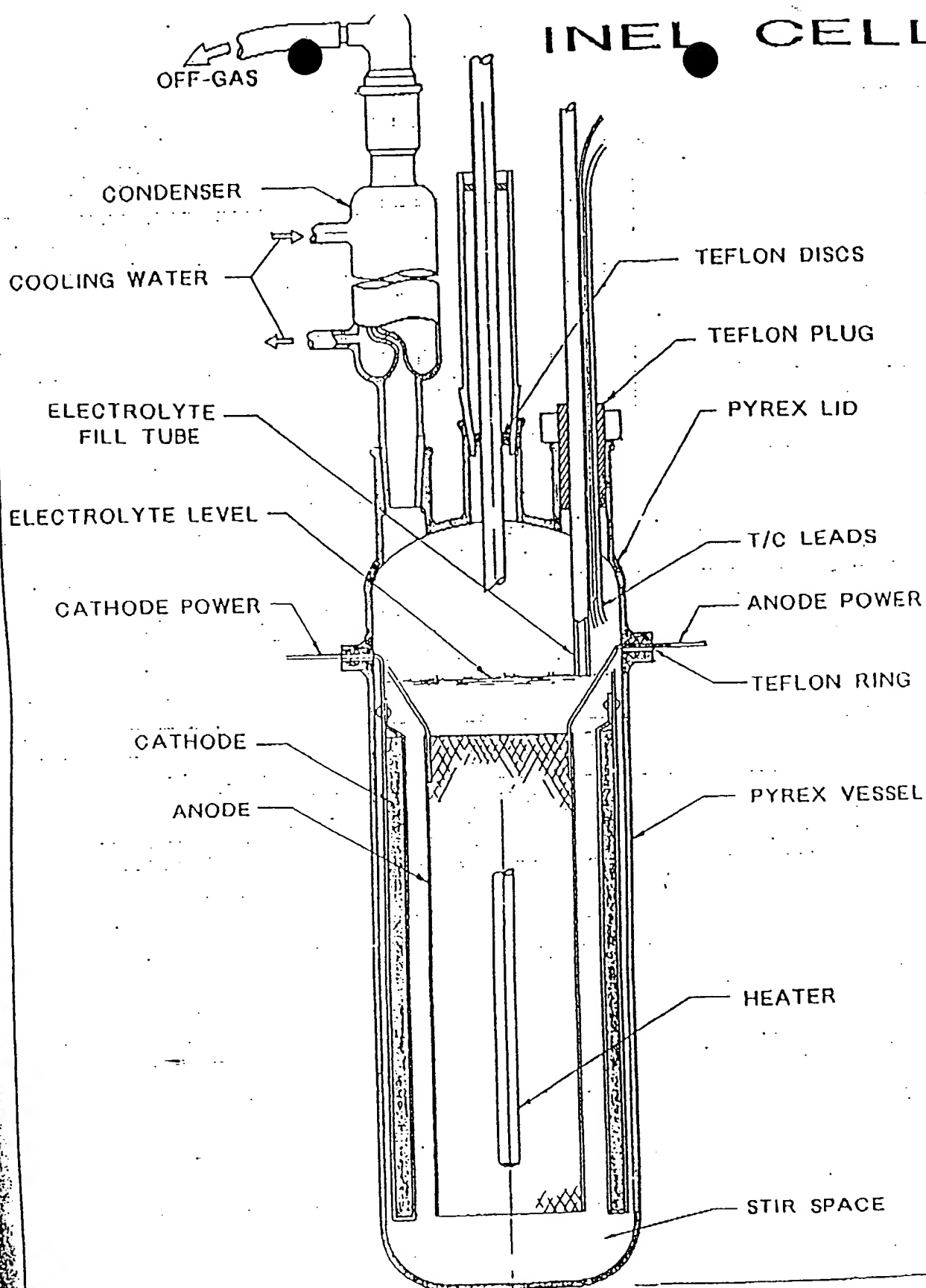
1. The straps are 0.5 in. wide rather than 1.0 in. wide. These narrower straps would be flat rather than arched to fit the winding curvature.
2. There are no secondary straps as were added to the windings of the first cathode assembly.
3. Windings would be less dense than the first winding. A much steeper pitch is probably necessary to achieve the more open wind.
4. Weight of the NI-200 wire of each winding should be very close to 3.33 pounds, and both windings should have the same weight as closely as possible.
5. Slots in the Teflon Bus Ring for the cathode straps would be 0.50 wide rather than the 1.0 width of the first ring.

FEB 04 '93 05:11PM OSLA

P.3/6

INEL CELL

# INEL CELL



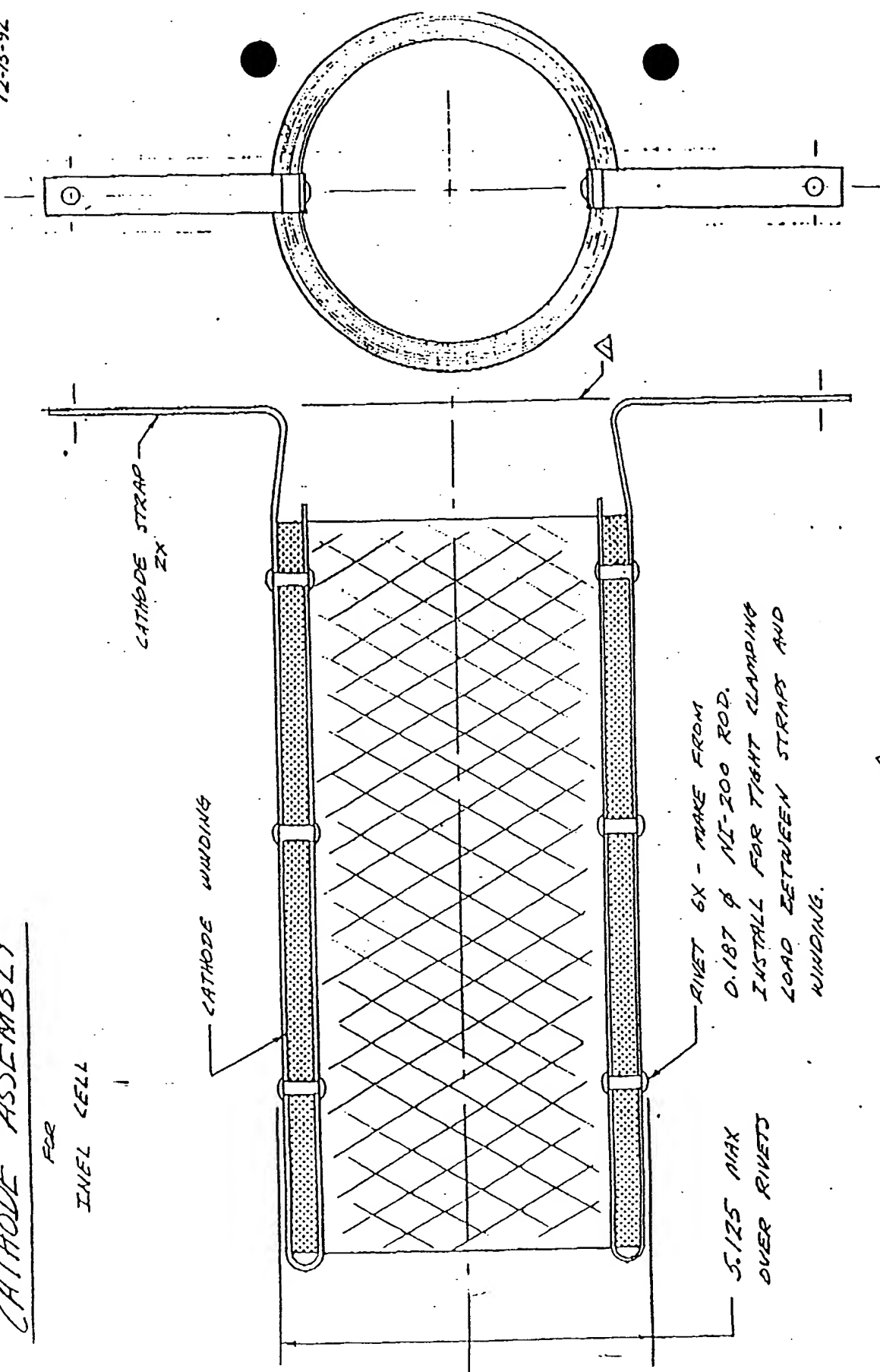
0 1 2 3 4 5 6  
INCHES



R22  
11-2592  
12-15-92

# CATHODE ASSEMBLY

FOR  
INEL CELL

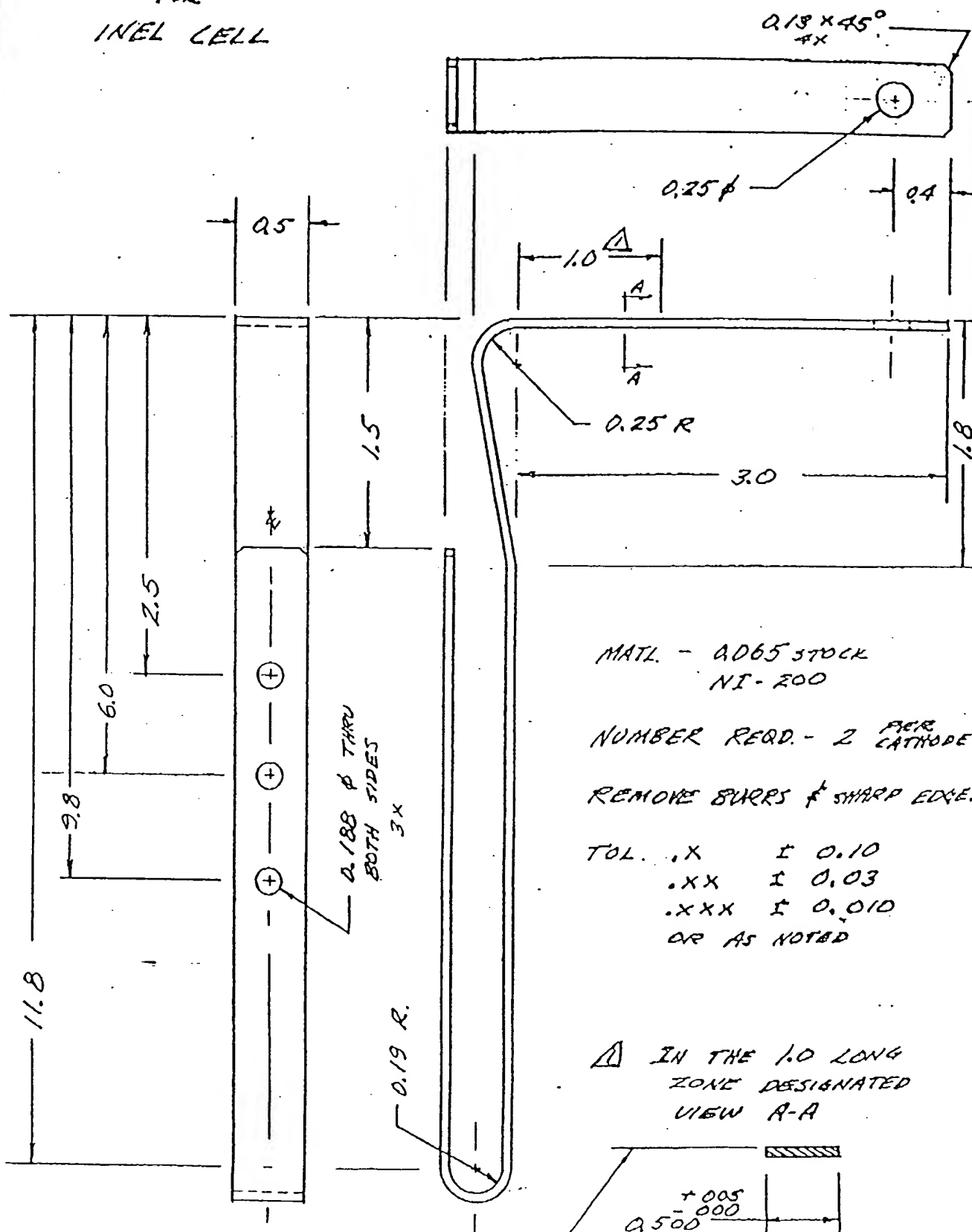


$\Delta$  ALIGN BOTH STRAPS  
IN PLANE AT 90°  
WITH WINDING &

# NARROW CATHODE STRAP

ALL  
12-15-92

FOR  
INEL CELL



SCALE - FULL

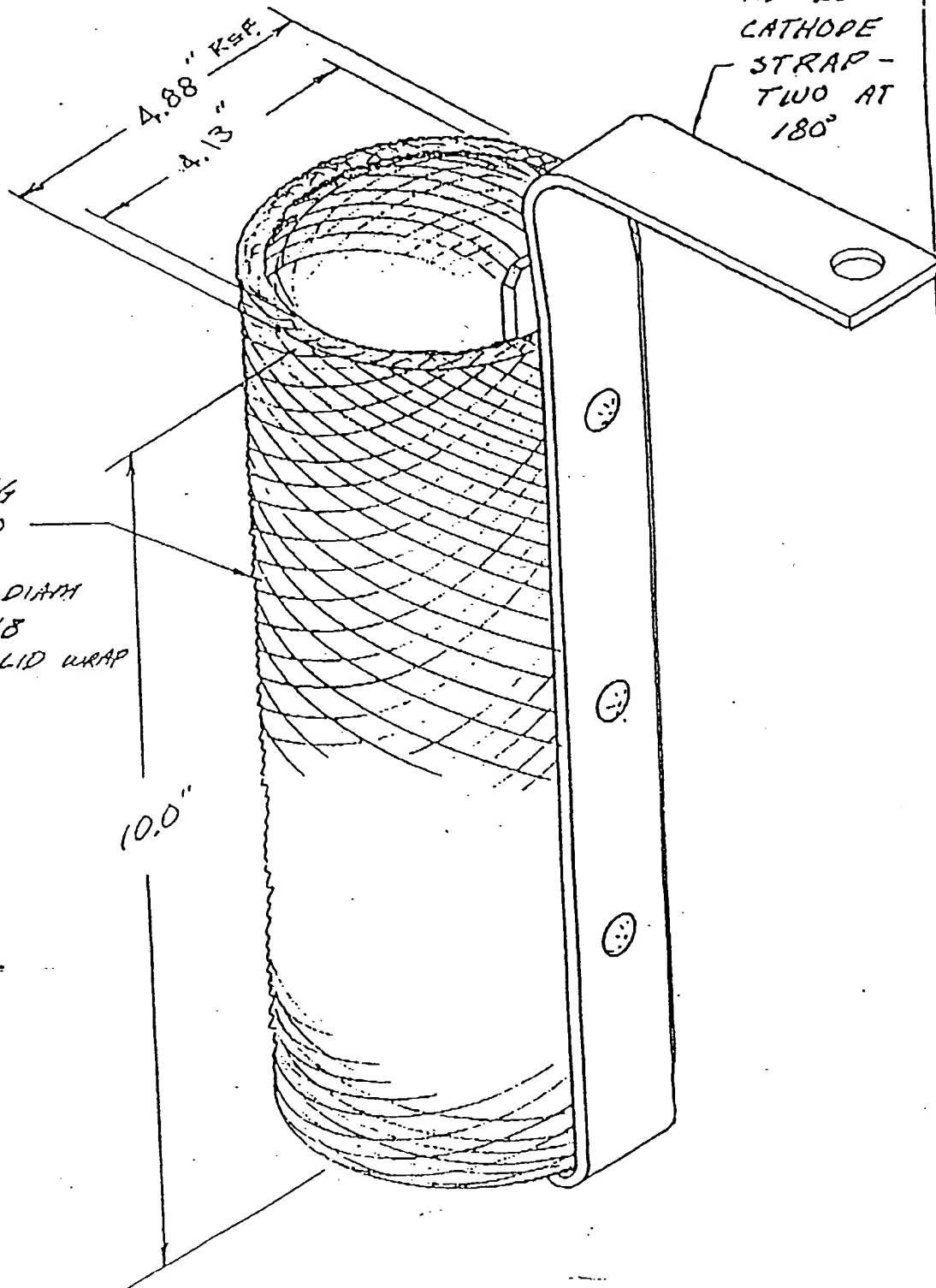
10-19-92  
10-21-92  
12-2-92

# CATHODE C-1

INEL CELL

NI-200  
CATHODE  
STRAP -  
TWO AT  
180°

WINDING  
NI-200  
WIRE  
0.010 DIAM  
3.33 LB  
0.2 SOLID WRAP



NUMBER RECD. — ONE PER CELL

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